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THE CONSOLIDATED ELECTRIC LIGHT CO.

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GENERAL OFFICE AND FACTORY,

510 to 534 WEST 23d STREET, NEW YORK.

ELECTRICAL REVIEW

ILLUSTRATED.

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Apparatus for Storage Battery Work.

The Electro Dynamic Company of Philadelphia has been devoting its attention, for the past year or more, to special forms of switches for use in connection with storage batteries. This is an entirely new field of electrical engineering, and involves the most intimate acquaintance with the ordinary uses and abuses of storage batteries. We illustrate a few of this company's recent designs in this field.

Fig. 1.—Is a very elegant form of car switchboard devised for use on the Florida Limited Pullman train, and contains an ammeter, a new and ingenious form of ammeter switch, a connection for a voltmeter, a small switch for measuring the different voltages of the lamp and charging circuits, and a switch for alternating the brilliancy of the lamp.

Fig. 2.—Is a single knife blade switch of convenient shape for rapid work.

Fig. 3.—Is the single pole dynamo plug switch, a form of connection for central station work, where it is necessary to make rapid changes from one charging circuit to another.

Fig. 3.

Fig. 5.—Is the manufacturing motor of the Electro-Dynamic Company, in which the lines of force are all enclosed by the iron of the field, which forms a box containing the entire apparatus.

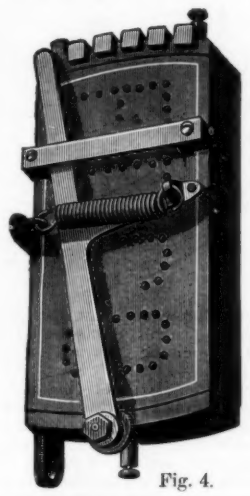

Fig. 4.

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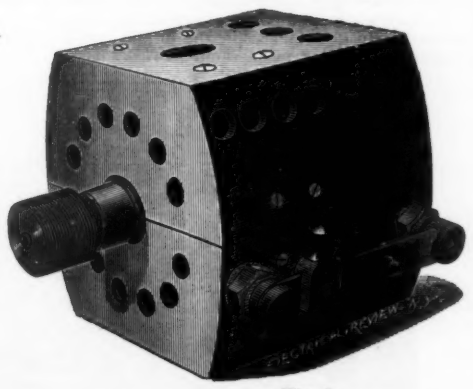


Fig. 5.

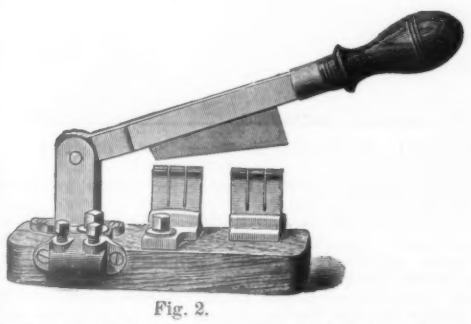


Fig. 2.

Fig. 6.

ELECTRICAL APPLIANCES FOR USE IN STORAGE BATTERY PLANTS, MANUFACTURED BY THE ELECTRO DYNAMIC CO., PHILA.

Fig. 4.—Is a little iron rheostat box used in connection with the pedal of a sewing machine or analagous apparatus, the iron of the lever being held by the spring in the position shown, which interrupts the circuit. This is used in connection with 60 and 100 volt circuits to regulate the speed of the well known "double induction motor."

Fig. 6.—Is the consumer's switch which enables the battery to be cut into or out of a charging circuit of high electro-motive force without appreciable spark.

That Notorious Board of Electrical Control.

Under the head of "Politics and Deals Rampant," the daily *Press* of last Wednesday says:

The United States Illuminating Company was taken by surprise Monday by the receipt of a letter from Police Justice John J. Gorman, announcing that the case of the Board of Electrical Control against the company had been postponed from July 12 to July 19, because it was found that more time would be required. Eugene T Lynch, the president of the company, said of this, when asked about it by a *Press* reporter;

"All that I have to say at present is that Justice Gorman is kind. But we certainly did not desire a postponement. The case is one to compel us to put our wires underground in Twenty-fifth street. We were ready for trial on Thursday."

President Lynch took occasion to criticise the statements of Commissioner Gibbens in which the commissioner said that the United States Illuminating Company had at its disposal for the use of its wires the handhole distribution method, by which a subsidiary pipe is run from the manhole to the street corners, along under the sidewalk, to a handhole at every house, the housetop distribution system and the lamppost system.

"The fact is," said Mr. Lynch, "that we are still waiting for the handhole system, and we abandoned the housetop system because the Board of Fire Underwriters refused to insure houses thus endangered; and that the lamppost system is ridiculous, because lampposts are only some eight feet high, and between posts the wires would not be more than five feet from the ground."

It was learned on good authority that there is much more behind the postponement of the suit against the United States Company than appears on the surface. A gentleman who speaks with authority said:

"It will not be many days before you see interesting developments in this matter. Politics and deals have been too rampant in the Board of Electrical Control, and there may yet be developments which will call for a legislative investigation."

Underground Electric Wires.

William L. Strong, president of the Brush Electric Light Company, says in regard to this matter.

"In the first place, those who are employed by the company know the danger they are subjected to daily, and if they fail to take the necessary precaution, as in the case of lineman Murray, they have no one to blame but themselves. In the second place, we afford our men means for protection. One hundred pairs of rubber gloves are issued at one time by the company and the employé can help himself. The fact is the gloves are given to them. Lineman Murray had a pair of gloves in his pocket when he was found dead. If he had worn them his life would have been saved. He had no business to handle the wire with his naked hands. The gloves are a complete insulator. The company has suffered severely and unjustly for his carelessness. If our wires were such instruments of death we should make a bigger mortuary report than we do make. Since the Brush electric lights were put on Broadway, in November, 1880, Murray's is the only death. That does not look as though death lurked along the entire line of an electric light wire. Much has been said pro and con as to the wisdom of burying wires. I think Prof. Morton's idea is correct His paper covers the subject thoroughly." The following is the paper in question.

STEVENS INSTITUTE OF TECHNOLOGY,
June 7, 1888.

My attention has naturally been attracted by the discussion in various daily papers of the dangers to life and property believed to come from the wires conveying electric currents for the production of light which traverse many of our streets. In this discussion certain very important facts seem to be generally overlooked and certain assumptions to be accepted as quite true without warrant, and it therefore appears to me that a few words drawing attention to these oversights and these assumptions would be timely and might help towards a rational and practical outcome from the discussion in question.

In the first place, it seems to be assumed that if the electric light wires were buried underground the accidents which have recently happened would have been avoided,

and it does not appear to have occurred to any one to ask if this is so. This question I now propose and attempt to answer. Suppose that all the electric light wires were buried underground; it would still be necessary that the lamps in which the light was produced should occupy their present positions and any one handling them would be just as liable to receive a fatal shock as at present. Indeed, for various reasons, connected with the action of electric induction and leakage, which it would take too long now to describe in detail, but which every electrician will at once appreciate, the risk in handling the uninsulated parts of a lamp would be greater if the wires were undergound.

Again, if the wires were underground it would be just as necessary as at present to handle them when making new connections, and the risks of fatal shocks while so handling them in cramped "man holes" or narrow conduits would evidently be much greater than where the wires are widely separated and exposed to full view in broad daylight with ample room to work in. The risk comes from handling a wire carrying a powerful current without the necessary precaution, and not from the fact that the wire is above ground rather than under it. The true deduction is: Don't handle the wires if it is not your business to do so, and if it is, be sure to take the requisite precautions. If this rule had been followed none of the reported accidents would have occured. If it were not followed the accidents would have happened just the same, had every wire in New York city been buried a year since.

Again, it is assumed that the putting of the electric light wires underground is simply a matter of reasonable outlay of money. This assumption also is entirely without foundation. As a matter of fact it is not possible by any means now known to operate electric lights which require dangerous currents with underground wires in any practical system. It is quite true that, in some instances, a few lights have been so operated as an experiment, but most of these experiments have ended in total failure, and the few which have survived have been so little encouraging that their promoters have been unable to persuade any one to extend their application into anything like the dimensions of a practical system. It is a curious fact that while our New York papers have been urging the authorities to put all wires underground a Parliamentary commission has advised the passage of legislation which should allow the running of electric wires overhead in London. In London, where the wires were ordered underground at the outset, electric lighting of the streets is practically unknown, and it would not be long before it was equally unknown in New York if the act to place all such wires underground were strictly enforced. The choice is, therefore, not between the present electric lighting and the same with underground wires, but between the present system and a return to gas.

Another fact which seems to have been overlooked is that the attempt to place all wires underground would result in such an original and continued upturning of streets as would almost render them impassable, and might cause more injury and loss of life from malaria in a month than the electric wires have occasioned in seven years. Moreover, it is to be observed that during the seven years which have elapsed since the general introduction of electric lighting in New York not a single instance has occurred in which an individual not an employé of an electric light company, attending to his legitimate business, has been injured in any way. Such accidents as have occurred have been either to employés or to others who were improperly meddling with wires or lamps.

In view of this, the systematic attempt to create a panic among citizens at large in reference to the electric wires is as foolish as it is discreditable. Compared with the injuries and deaths caused by matches, by kerosene lamps, by gas, by vehicles driven in the streets, and by a host of other agencies, the electric wires have been relatively harmless, and inasmuch as they have replaced more dangerous means of illumination, and have rendered the streets safer at night, I have no doubt that the electric wires have effected a large net saving of life and prevention of accident. HENRY MORTON.

—— The National Electric Light Association will meet in New York, August 29th, at the Hotel Brunswick. Electric light men should make a note of this.

—— Portable electric lights, to be hung to a coat button, are the new invention for the benefit of readers upon cars. Thus each one can become his own lightning bug.

—— The Board of Electrical Control of New York, has posted up notices warning all persons who own "dead" or dangerous wires and unsafe poles to remove them at once or alter them so as to make them safe. The notices are posted in the neighborhood of the condemned property.

Electric Railways.

THE SOLUTION OF MUNICIPAL RAPID TRANSIT.

Paper by FRANK J. SPRAGUE, before the Institute of Electrical Engineers, June 19th, 1888.

The presentation of this subject before the American Institute of Electrical Engineers for discussion seems to me most opportune. It is a question of great importance, and one for which a definite solution is fast becoming imperative. To those of us who believe that the solution is to be found in the application of electricity, it has a special significance, and I trust that what I say may bear fruit by starting a general discussion of the subject, not only among electrical men, but the general public as well.

More attention is now being paid to the question of tramway traffic than ever before. The reason is not only the comparatively high cost of operation under the present almost universal system of horses, but also because the public are beginning to feel, and the street railway men are beginning to see, that it is a system behind the times. Laying all humanitarian questions aside, the public demand a better and a more rapid service. Railway men want to give it, provided they can do so for the same or less money than they are now spending.

To quote from a New York evening paper:

"The rapid transit question has steadily pressed its way to the front of subjects demanding immediate attention, until it now stands in this city the foremost question of the hour.

"The fact is made evident by the eager discussion upon every hand of the very best means by which the end may be attained with the least possible delay. The total passenger traffic, that is, the total number of persons carried, of this city, has increased at the rate of over 140 per cent. in each period of ten years since 1866, and is now something over 325,000,000. At the same rate of increase, it would amount in 1890 to over 500,000,000, and in 1900 to 1,225,000,000."

There is every reason to believe that the through traffic will increase as much as expected, because the city is growing rapidly and its business section is continually enlarging and pushing northward, forcing the larger part of the population, especially the laboring classes, to seek homes in the upper portion of Manhattan Island and the Annexed District, where rents, already increasing because of the increased facility of access, are still lower than can be readily commanded for business purposes in the lower part of the city. The elevated roads of this city, although carrying 500,000 people a day, do not answer the requirements of rapid transit, either local or through; nor is it possible for any two-track railway to do so.

By rapid transit we do not mean merely through transit; we ought not to consider alone the methods of transportation from one end of the city to the other, or from the city to the suburbs; we are likewise called upon to find some means by which the local traffic shall be benefited. Everything which lessens cost of operation, increases speed, reduces intervals between cars, increases the number of cars and makes extensions possible, aids rapid transit, no matter whether surface, underground or overhead.

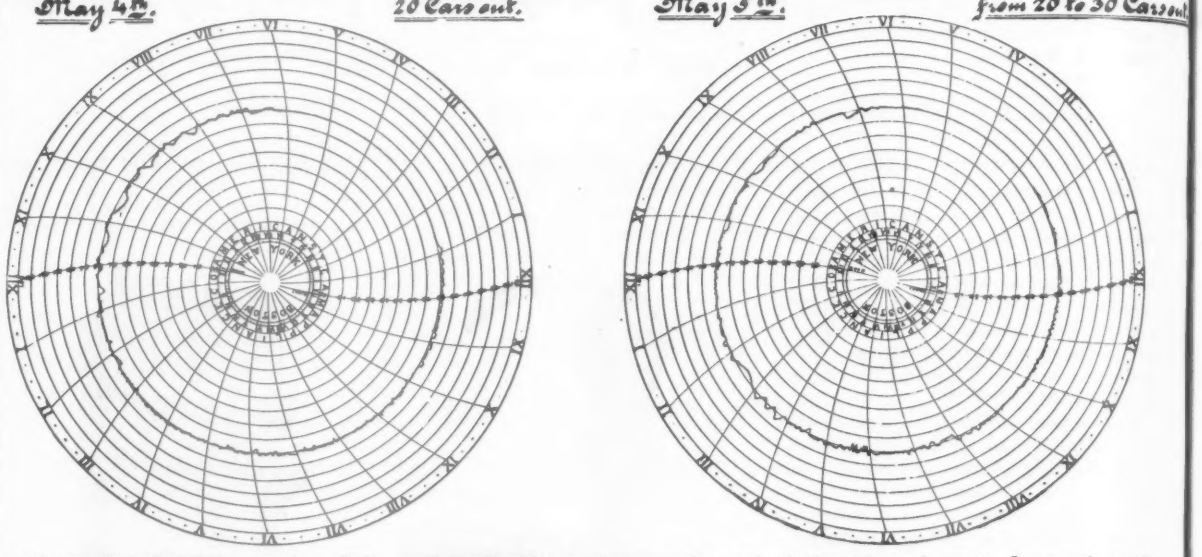
With the same cost of operation, provided the motive power is materially cheapened, a greater number of cars can be run, intervals can be shortened up, large cars can be run in the place of small ones, better attention can be afforded, cars can be better heated, lighted and cleaned; they can make better time, people can be carried further for the same money, branches can be opened in districts which would otherwise not pay, and what is all important, more passengers can be carried, and for this reason alone more money can be made. For years an attempt has been made to replace the horse with motors of various descriptions—compressed air engines, fireless engines, hot water and soda motors, naphtha and petroleum engines and steam engines. But we can safely say that the question has to-day narrowed itself down as between the cable and the various electric systems for surface work, and between electricity and steam for elevated or underground work.

In order that we may be in a better position to judge of the comparative economy and the relative advantage of present and proposed methods of traction, I will briefly consider, first, the use of horses.

Two distinct methods are recognized among street car men in the handling of their stable equipments. In one, the stock of horses is kept as low as possible; they are worked hard, making 14 or 15 miles a day, and the depreciation is very heavy. In the other, the stable equipment is increased; the horses are kept in excellent condition; their average daily duty is reduced to 10 or 12 miles, and the depreciation is lessened.

Assuming the cost of a horse as $150, and the cost of feeding and caring for him as $180 per annum, it would seem that any accurate knowledge of the average life of horses under different day's duty would

Steam Diagrams of the Richmond Union Passenger Railway Co.



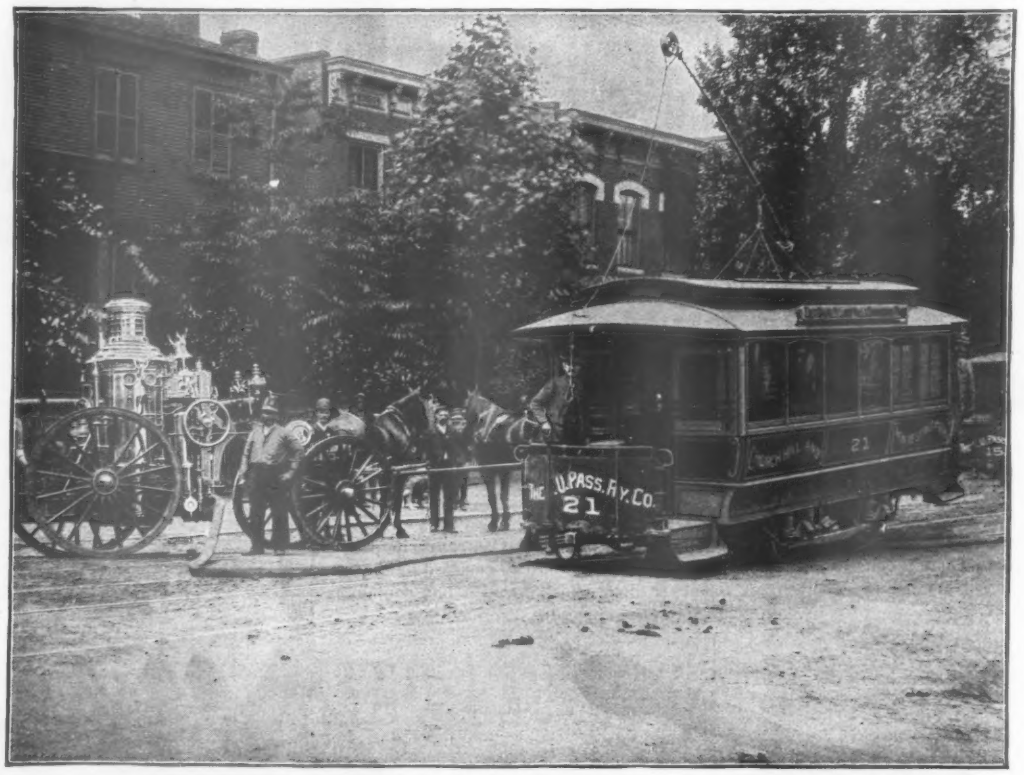


FIG. 1.—VIEW OF ELECTRIC CAR AT RICHMOND, VA., JUMPING FIRE HOSE.

With the same cost of operation, provided the motive power is materially cheapened, a greater number of cars can be run, intervals can be shortened up, large cars can be run in the place of small ones, better attention can be afforded, cars can be better heated, lighted and cleaned; they can make better time, people can be carried further for the same money, branches can be opened in districts which would otherwise not pay, and what is all important, more passengers can be carried, and for this reason alone more money can be made. For years an attempt has been made to replace the horse with motors of various descriptions—compressed air engines, fireless engines, hot water and soda motors, naphtha and petroleum engines and steam engines. But we can safely say that the question has to-day narrowed itself down as between the cable and the various electric systems for surface work, and between electricity and steam for elevated or underground work.

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All railway returns do not, strange as it may seem, give accurate information on which such estimates of cost can be made, but from such facts as are given, we may deduce the following: Taking the returns for 1887 for the five largest roads in Massachusetts, we find that they show 6,909 horses and 1,410 cars; that the mileage made was 12,834,665, and the passengers carried 76,187,842.

Dividing the average daily mileage by the number of horses, and multiplying the number of horses in a team, we find only 10.26 miles as the average daily duty for all

teams, sick or well. Horses which are on duty make from 12 to 14 miles.

On the West End road of Boston, which is now the largest street railway combination in the world, having about 212 miles of track and over 8,000 horses, 10 per cent. of the horses are counted as being off duty from illness, sprains, shoeing, or other causes, and the balance of the horses average about 12 miles a day. A car day is estimated at 10 to 11 hours, and from 45 to 50 miles, and eight horses are allowed as the active force.

The rule given me by one of the officials of this company as a fair one to determine a stable equipment is, to divide the total daily mileage by the miles made in a car day and multiply it by nine, adding what is necessary for hill horses. Hence, if 50 miles is a car day duty, a daily run of 1,600 miles would require a stable equipment of 288 horses, besides those for hill work.

On the Fourth avenue line in New York, the stable equipment is determined as follows: A car day is 11 hours, and eight horses make about five trips, aggregating about 50 miles. To this number is added 10 per cent. for illness, sprains, etc., and 10 per cent. for emergencies. On this road is illustrated the influence of an important factor in horse car work— that is, the position of the stables. Horses from the upper stable are limited to 11 miles, or otherwise they would have to make 22 miles, while horses from the lower stable have to make about 13½ miles, or considerably more.

The average cost of motive power per car day throughout the United States, that is, for from ten to eleven hours and trips aggregating from forty-five to fifty miles, is about $4. This counts only those horses on actual duty on the road. The cost of motive power per car day for equal mileage in Richmond is less than $2 on the heaviest sort of grade work. The total operating expenses of a horse railway average for the five largest roads in Massachusetts 25.15 cents, and for all the roads in Massachusetts 24.7 cents per car mile; and the ratio of operating expenses to gross receipts is, for all the roads, 86 per cent.

The cost per day per horse, based upon the returns of four of the largest roads in New York, is 54 cents, and the cost per car mile from 9½ to 10½ cents per car mile.

In addition to the regular depreciation there is ever present danger of an epidemic in hot weather.

Since the cost of the motive power alone—that is, the cost of harness and stable equipments, horse-shoeing, renewals, provender, hostlers, etc.—is 40 per cent. of the total operating expenses, it will at once be seen how vitally important any material saving in the cost of motive power becomes. If, as we claim, the cost of motive power in an electrical system is one-half or less than that in a horse system, the percentage of gross receipts available for interest and dividends is more than doubled.

Furthermore, when we remember that the average running time for horses is only five to six miles per hour, we have another reason which constitutes an unwarrantable objection to the uses of horses for rapid transit.

Among the systems which have been proposed to take the place of horses, and which have given the most promise and met with the greatest success where heavy grades and traffic exist, is the cable system. With its general features you are probably familiar.

There are, however, a great many objections. One of the most serious is the great initial cost of the construction and plant, the cost of the conduit alone ranging anywhere from $50,000 to $80,000 per mile of single track, making the investment so large that none but roads having heavy traffic can permit of the expense.

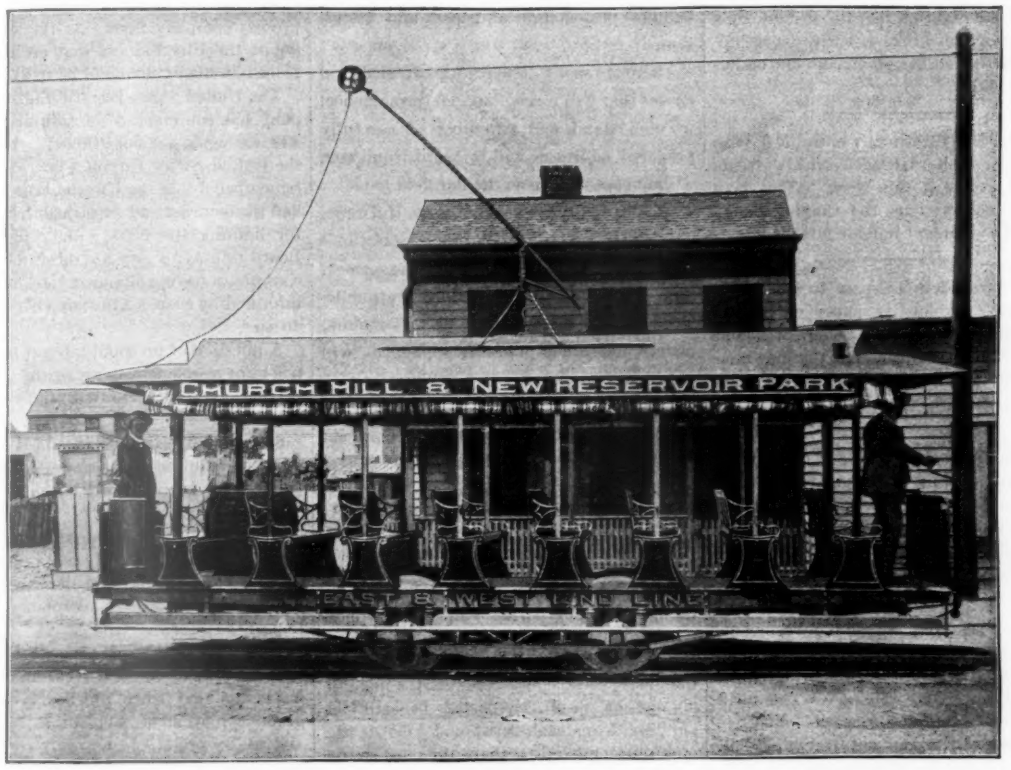

FIG. 2.—ELECTRIC CAR, SHOWING OVERHEAD WIRE AND TRUCK

The conduit is necessarily large and costly, in order to accommodate sheaves of sufficient size to prevent too great a loss in friction, and on account of the position of the cable and pulleys, it is difficult to clean it. This large size also makes it difficult to construct a conduit which will not, because of the traffic and weather strains, be distorted and have the slots forced together or apart. The depth varies from two to three feet, more often the latter, and in any city street this is almost certain to interfere with steam, gas, or water pipes.

Each section of the line being a unit and being operated from one cable, a break in the cable will suspend the entire traffic of that section.

A broken strand is apt to foul the grip and pile one car on top of another, as happened in Philadelphia, or suddenly start a car which is at rest, as recently happened on the 125th street line in this city. The cable is a heavy, cumbersome affair, 1¼ inches diameter, and weighs about 13,000 pounds to the mile.

It is found that it is best to make these cables in 20,000 ft. length.

If a cable is stranded, it cannot be used until repaired; if it is stretched 1 per cent., it is considered unsafe. These weaknesses of the cable system render it necessary to have a duplicate cable ready for instant use, and a double line of sheaves.

With a full load, not over about 20 to 25 per cent. of the power of the engines is actually used for the propulsion of the cars, the balance being for moving the cable. With any light load, the efficiency is even less. But it has been found advisable to have even greater power than this, most of the companies having from two to four times as much engine-power as is required at any time, and from one and a half to twice the boiler-power. This is necessary, because if any part of the cable engine breaks, the whole section of the system is disabled.

Every turn in a cable brings a strain upon the grips and reduces the life of the cable, and any increase in the speed at which a cable is driven likewise shortens its life.

Difficulty exists in turning corners, expensive drums, and oftentimes auxiliary cables being required. Constant care and attendance is necessary in lubricating the carrying and curve pulleys, and in taking care of the slots and switches, the estimates for Boston being about $3.20 per day per mile of single track, requiring the time of one man per mile. It is impossible to work turnouts, cross-overs or sidings without auxiliary cables, or to operate single tracks.

A line once being put in, any extension is expensive and difficult, because of the terminal machinery which is necessary, and the definite length of the cable.

The speed is limited; a car cannot travel faster than the cable and thus recover lost time, except on down grades; nor can it travel more slowly save by permitting the cable to slip. The regular speed then, must be the same in the most crowded sections of the street as in the less populated sections.

The starting is often with a jerk, and the whole motion of a lurching, unequal, unpleasant character, exceedingly disagreeable when first experienced.

Success in the cable railway system considered by itself, depends largely upon the condition that a line of reasonable length shall be so located as to warrant frequent car service.

The chief advantages of a cable are, the cheapness, as compared with horse-power, of operating a heavily patronized road at a comparatively fixed rate of speed, with no regard whatever to grade or gravity; but this cheapness is not inherent to the cable system, but due rather to the fact that steam has such a tremendous advantage over horses.

The motive power operating expenses vary from 50 to 70 of the cost of operating by horses.

Now, what is it electricity by some of its systems promises us for the ordinary street traffic? What are its advantages? First, it will do the work, and in a far more satisfactory manner and at a greatly lessened cost of operation than with horses. Electricity is simply an agent for which we have to pay a certain proportion to carry the power of our steam engines to take the place of the horse. Since not only on levels but also on the up and down grades an electric car can be run much faster than a horse car, and because it can be gotten under way and stopped much more quickly, the mileage with any given number of cars can be increased, the mean running speed increased, and the same time intervals made with a less number of cars; or, on the other hand, shorter intervals be made with a given number of cars. The equipment will occupy about 35 per cent. less space, the horse space being saved, and this fact, together with the ability to back when necessary, and to quickly gain headway, enables an electric car in narrow and crowded streets to work a passage through where horse cars would be at a dead stand still. Not only can cars run down grade faster, but also with much more safety, because of the possibility of the instant reversal of the motors in the event of the parting of the brake chain; and when arriving at the

(*Continued on page 7.*)

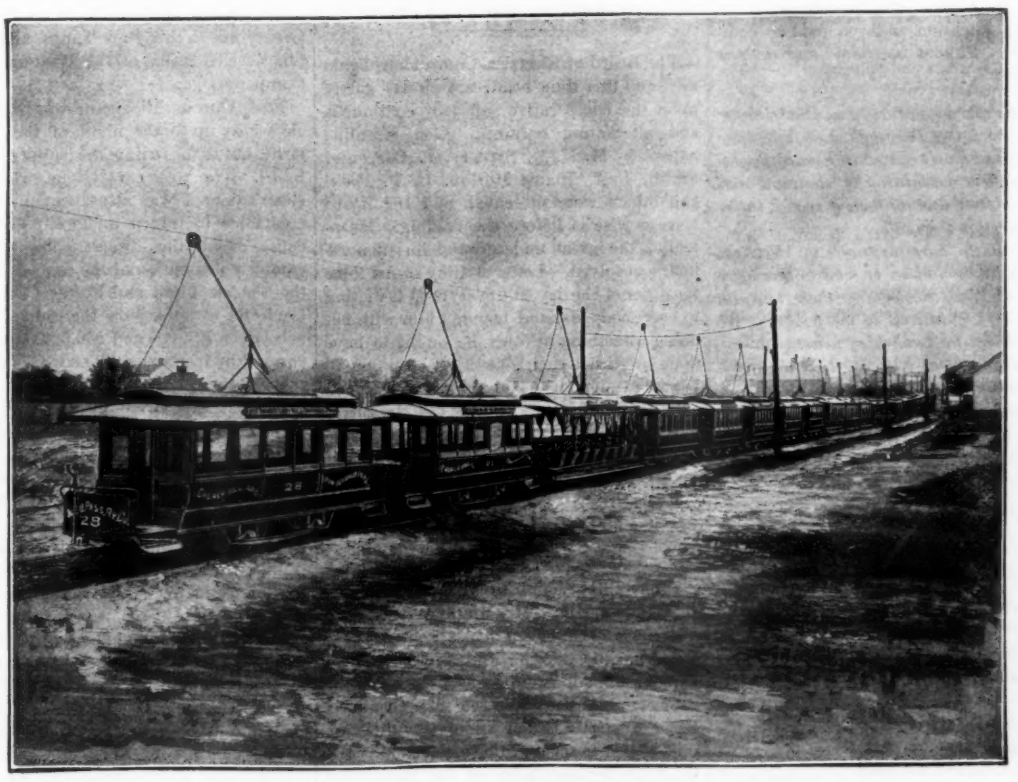

FIG. 3.—LINE OF CARS ON THE ELECTRIC RAILWAY, RICHMOND, VA.

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☞ No attention will be paid to communications without the *name and address of the writer.*

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We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

Subscribers can at any time have the mailing address of their paper changed by sending both old and new address.

Timothy W. Sprague, Massachusetts Institute of Technology, is our representative at Boston, Mass. Mr. C. C. Haskins, 118 La Salle Street, Chicago, Ill., represents the REVIEW in the West.

NEW YORK, JULY 21, 1888.

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This issue of the REVIEW is Vol. 12, No. 21, of July 21. The figures 1 and 2 will do to bet on in electrical circles this week.

The present is an excellent time to get ready for the coming National Electric Light Convention. Electric light men should be in New York in force next month.

Forty arc lights were extinguished in St. Louis, on the night of the 4th instant, by a sky rocket which broke the wire in its upward flight. Another pointer for the underground workers.

The Board of Electrical Control is having the question of alternating electrical currents presented before it this week. This is a good sign, and we hope the Commissioners will receive abundant reliable information.

We give considerable space to Mr. Frank J. Sprague's exhaustive paper on electric railways this week. Our readers will find it full of valuable information, that has been secured by the author in the field of practical operation.

Predictions are freely made of the collapse of the French copper syndicate. There have been rumors for some time that such a collapse was likely, but the only section to be directly affected in the country in this event seems to be Boston.

The English and French governments have agreed to work jointly, on and after January 1, 1889, the submarine cables between France and England. The tariff will be twenty centimes a week. A direct cable between Liverpool and Havre will be established under the arrangement.

The REVIEW desires to thank the Buffalo *Christian Advocate* for the following very kind editorial comment which appeared in its issue of July 5th: "The ELECTRICAL REVIEW is one of the most ably conducted scientific journals that comes to our table. Bright, progressive, and liberal, it is *the* journal for the amateur or the scientific electrician."

The Board of Electrical Control have again met, and this time heard arguments galore upon the comparative safety of continuous and alternating currents. Able scientific papers by M. M. M. Slattery, T. Carpenter Smith, Prof. Henry Morton, C. T. Peck, and others were presented, and the Board were as wise as before the reading. Meanwhile, the great underground question remains unsolved. Letter writing seems to be the order of the day, and everybody is writing to everybody else and blaming him with not doing something or other he ought to have done or with doing something he ought to have left undone. But the world wags on calmly, and if it does nothing else the Board affords a good deal of amusement to the quiet observer who can look on and laugh at the silly and useless bickerings of so august a body as this.

A PACIFIC OCEAN CABLE.

Probabilities point to a new cable line across the Pacific. Mr. Matthew H. Gray, a well-known engineer, has recently spent some time in Chicago with his friend, Dr. G. R. Ghiselin, and is quite enthusiastic on the subject. Mr. Gray was sent to Vancouver, B. C., Australia, and other points with which it is desired to secure cable connection. Mr. G. is the representative of the Silvertown Submarine Cable Company, of London, and it now seems certain that the cable will be laid. It will run from Vancouver to some Australian port, and cost from three to four millions of pounds sterling—$15,000,000 to $20,000,000. The Canadian Government is interested, and a boom has sprouted in Vancouver property in anticipation of the happy results foreshadowed. The REVIEW hopes to see this great and valuable enterprise succeed.

THE ELECTRIC LIGHT CONVENTION.

New York will have the privilege of again meeting the progressive body of gentlemen that composes the National Electric Light Association. August 29th, 30th and 31st are the days set apart for this meeting at the Hotel Brunswick. It is safe to predict a large gathering, and a most interesting and valuable presentation of papers and discussion.

There are many new features in electrical circles that will receive special prominence, we understand, and a number of carefully prepared addresses will be heard from men of eminence in their particular field.

Underground wires will be a fruitful topic, as of yore, and the result of the Association's deliberations in this respect, at the present time, will be closely watched by the public.

The recent advances in electric motors, meters, and other practical appliances, will receive attention.

The REVIEW takes this opportunity to strongly urge all electrical men to be present at this meeting. Every lighting and power company should be represented.

OUR CHICAGO LETTER.

(Special Correspondence.)

Several methods have been elaborated for the protection of parties employed by electric light companies while on duty around the dynamos and out on the line. Among the many, the Electric Safeguard, a metallic cut-out or shunt, connected beneath the clothing from each wrist and knee to the opposite member, is perhaps the most simple and best known. The theory of its action is that a current, which otherwise would all pass through the body, is divided at the point of contact, and a large portion of the force takes the metallic shunt. I haven't tried one of them yet. That may come later on—but in the meantime the Electrical Supply Company here is placing them in the hands of linemen, trimmers, dynamo engineers, and others who need protection.

La Grange, Indiana, is to be lighted by twenty-five to thirty arc lamps, and the system selected is that of the Western Electric Company.

Port Huron, Michigan, was lighted by electricity up to the night of the 10th instant, but that evening the supply of force failed. The steel car system, which is an electrical one, was also incommoded, and compelled to return to horse-power. The cause of all this disarrangement was the complete demolition of the central station of the Electric Light and Power Company by fire in the afternoon on the 10th. The loss is between $15,000 and $20,000, and is fully covered by insurance. The works are to be rebuilt at once.

An old and well-known telegraph operator, Fred. L. Wellner, shot himself in the right temple at Pittsburgh, on the 8th instant. Wellner was one time a first-class operator and shorthand man. He worked for the Western Union at Chicago, and had at one time a lucrative employment in the various courts. He originated the idea of using the typewriter in connection with receiving. Fred was unfortunate, and fell into the opium habit, with which he struggled for five years, only to constantly lose ground, until he became a miserable physical wreck. He had been twice married, and leaves a wife and two children.

The Chicago & Northwestern Railroad bridge near Kinzie street, has been, until latterly, independent of the telephone system, and while the balance of the bridges were under some discipline, this one was a law unto itself, and of course it made lots of fun for the vessel men. The vessel dispatcher has it now, and one more bug in the river telephone system is picked out and destroyed.

At the last meeting of the council, Alderman Ernst's ordinance, which limits telephone companies to an annual rental of $75, was referred to the Committee on Licenses. The Alderman was quite anxious it should be taken up and passed at once, and he made the endeavor by moving a suspension of the rules, a suggestion which was defeated by a vote of 24 to 17. As a two-thirds vote was necessary, the ordinance will now have another vacation.

Some time since it was proposed to grant a franchise to the Inter-State Telephone Company, to enter into competition with the present company here. At the same meeting of the City Fathers that ordinance was placed on file by a vote of 23 to 21.

The United States Electric Lighting Company has commenced an assumpit suit for $40,000 against Cook County, Illinois, in the United States Circuit Court. It will be remembered that the United States Company had the contract and furnished the apparatus for lighting the county buildings and the Board refuses to pay anything more on the contract, it having already paid $20,000 since informed by State's Attorney Grinnell not to do so.

A question of no small interest to the electric light people hereaway, of the glow lamp persuasion, is "Who will light the Auditorium?"

Somewhere near 9,000 incandescent lamps will be required, and several of the companies have been figuring hard and long on estimates.

On Friday it was rumored that a portion of the plant had been offered to each of two prominent companies, but these had neither of them signified their acceptance or rejection of the offer.

The whole contract will be so gigantic, and be subject to such rigid and constant inspection that when finished it will be a grand achievement—a plant to be admired and to be proud of, not only by the constructors, but by the city as well.

Another result of poor line wire was reached the other day at Parkersburg, W. Va. Mr. J. E. Mayhew, manager of the telephone company, was assisting a lineman in making some repairs, when he received a severe if not fatal shock from contact between the telephone line and a poorly insulated electric light wire. He was rescued by his assistant, who had the presence of mind to cut the lighting wire, and thus, at no small risk to himself, stop the flow of current. It was probably another case of undertaker's wire. C. C. H.

Chicago, July 16, 1888.

ELECTRIC LIGHTING AND INSURANCE.

The New England Insurance Exchange has issued the following circular:

To Companies and Agents:

Following is a complete list of electric light companies, or "systems," that have complied with all the requirements of this "Exchange," and whose installments and apparatus will entitle the assured to rebate in tariff rates, in accordance with vote of March 31, 1888, heretofore promulgated.

No allowance will be made for the apparatus of any company or system not named in the following list:

American Electric Manf'g Co., Ball Electric Light Co., Bernstein Electric Light Co., Brush Electric Light Co., of Cleveland, Ohio; Edison Electric Light Co., Edison United Manf'g Co., Fred. M. Kimball & Co., of Boston; Loomis Electric Light Co., Mather Electric Light Co., Sawyer-Man Electric Co., Schaefer Electric Manf'g Co., Sun Electric Light Co., Thomson-Houston Electric Co., Tremont Electric Lighting Co., United States Electric Lighting Co., Waterhouse Electric and Manf'g Co., Westinghouse Electric Light Co. Respectfully,

ARTHUR A. CLARKE.

S. E. BARTON,

Chairman Electric Light Committee.

The Schuyler electric light system is the only one not included in the above, says the Boston *Commercial Bulletin*, the reason being that they refuse to co-operate with the Exchange in matters of fire protection. It is understood that the companies will not insure stations using that system.

Phonograms have been received at Edison's laboratory containing the eloquent words of Gladstone and the tones of the divine Patti's voice. They were sent over by Col. Gourand, of London, who secured them on the new phonograph of Mr. Edison recently sent to him.

OUR PHILADELPHIA LETTER.

(Special Correspondence.)

The most interesting item of electric news in Philadelphia this week is that referring to the stand taken by the Keystone Light and Power Co. (Westinghouse system) in assertion of their chartered rights to occupy the streets of the city with their conduits and wires, despite the opposition of Councils and other municipal authorities.

As it is to be presumed that many lighting corporations in other States than Pennsylvania possess similar charter rights, the following account of the position taken by the Keystone, as presented in the *Daily Press* of July 12, will perhaps be valuable information to many of your readers.

It may be well to premise this account by stating that the Keystone is at present supplying about 2,000 lamps in a territory adjacent to their central station, at Seventh and Samson streets, and for this purpose were granted by Councils the right to lay their conduits and wires in that limited district, they being the first in the field to furnish incandescent lights, on any extensive scale, in the city.

Shortly after this, a consolidation of interests was effected between the Electric Trust, the Penn Electric and the Edison Companies, with the object of controlling all public lighting and all underground wire-laying in Philadelphia.

The Keystone were afforded an opportunity to come into the deal, but preferred to maintain their independent attitude; this has made them popular with the masses, but quite the contrary with the "Ring," and they have not been able to obtain from Councils any further territorial rights to lay conduits, although repeated and continuous efforts to that end have been made.

Hence the necessity of ignoring the city authorities and of falling back upon their rights of charter as acquired from the State. How they propose to do this is as follows:

The Keystone Light and Power Company gave notice to the city by a bill in equity, filed in Court of Common pleas No. 1, that it proposed, notwithstanding, to lay its conduit, and asked the court to grant an injunction restraining the city and its officers, agents and employés, from preventing, or in any way interfering with the company "in entering upon any public street, lane, alley or highway of the city for the purpose of laying down its conduits, pipes and wires for the supply and distribution of electricity for lighting and power."

The bill quotes from Section 34 of the Act of 1874: "It is enacted that corporations for the supply of light to the public by any means as well as by gas, shall have authority to make, erect and maintain in the city where such company may be located, the necessary buildings, machinery and apparatus for manufacturing light and distributing the same, with the right to enter upon any public street, lane, alley or highway" * *

The company had acquired on August 5th, 1886, by ordinance of Councils, the right to build its conduits on certain streets, and on the 16th day of February following it made application to the Board of Highway Supervisors, accompanied by plans, for its approval to an amendment of the ordinance, greatly extending the privileges already granted. Included in the amendment was "Sansom street to the Schuylkill River," instead of "Sansom street from Sixth to Ninth streets."

The Board of Highway Supervisors took the application into consideration, and on April 21 recommended to Councils an ordinance substantially the same as proposed by the company. Councils referred the ordinance in usual course to the Electrical Committee. The committee returned it to Councils on June 2, recommending approval. On June 16 when the bill came up on motion of Mr. Graham, chairman of the Electrical Committee, it was recommitted to that committee. The bill died in this committee, as it was not reported back to Councils before the first Monday in April, 1888, at which time the term of that Council expired.

Thus the matter rested until the 25th of June last, when M. Richards Muckle, Jr., secretary of the Keystone Company, wrote to the Director of the Department of Public Works, making application for a permit to lay conduits over the route approved by the Board of Highway Supervisors. To this the Director replied: "Councils having failed to pass the ordinance giving your company the right to lay underground conduits, I am not able to grant you the permission you ask." Upon this refusal Mr. Muckle wrote to Mayor Fitler. To this reply was made over the signature of the mayor's secretary that the mayor "cannot permit you to open Sansom street from Ninth street westward as you in your communication state you will do. Should the attempt be made it will be his duty to have the work promptly stopped."

The application for an injunction will be argued before the full bench in Court No. 1 on Saturday next. S. H.

Philadelphia, July 16.

SOUTHERN ELECTRICAL NOTES.

(Special Correspondence.)

A contract has been closed with the Westinghouse Company of New York for the establishment in Montgomery, Ala., of an incandescent plant, in addition to the Brush plant already operated there.

It is announced that the Electric Street Railway Company, whose buildings were recently destroyed by fire, will rebuild at once. Mr. William Wallace, the foreman for the above company, who jumped from the third story of the company's building during the recent fire, and whose leg was broken by the fall and amputated, is progressing very fairly, and hopes of his recovery are now strongly entertained.

Another accident from which death resulted is reported from New Orleans. A few nights ago a colored man named Louis Johnson leaned against an electric light post in that city, and placed his hand on the wire used for raising and lowering the lamp, and was dead in an instant.

The second tower of the Electric Light Tower Company of New Orleans is now in course of erection, and this big undertaking, it is thought, will be completed within one year, the time allowed, provided the iron is supplied as rapidly as the workmen require it. A very general approbation is reported among the citizens favoring the tower for lights and for wires, both telephone and telegraph, this system being preferred to the underground conduit because, for one reason, of the damp soil of New Orleans. It is said that several cities, among them St. Louis, contemplate sending committees of citizens to New Orleans, to investigate the advantages of the tower system of stringing wires, immediately after the completion of the tower and the inauguration of the system. The towers are of an attractive style, very light, and less obstructive to the view than the ordinary electric light towers. They are 150 feet in height. The city, in granting permission to construct the tower, stipulated that an iron hose should be run up each tower, to be used in extinguishing fires, especially on the uneven and higher buildings, which cannot be reached by the fire engines.

The Louisiana Electric Light Company, of New Orleans, claims to have the largest electric light plant in the world. This company propose to lay a cable two-thirds of a mile long under the Mississippi River, to operate electric lights in Algiers, situated on the west bank of the river, and containing a population of 12,000 people. The town covers an area of a square mile and a half.

The Brush and Hauss Electric Light Companies of Chatanooga, Tenn., have pooled their issues and have organized a consolidated company, with the following officers: President, D. W. Hughes; vice-president, D. J. O'Connell; secretary, H. M. Wiltse; treasurer, J. C. Anderson. Board of directors, D. W. Hughes, Julius Balke, Jr., D. J. O'Connell, F. F. Dillie, of Cincinnati; J. C. Anderson and H. M. Wiltse. Mr. G. W. Drach, representing the Shafer Electric Lighting and Power Manufacturing Company of Boston, which recently became consolidated with the Hauss Electric Lighting Company, was present at the final conference between the stockholders of the two companies. The name of the new concern is the Chatanooga Electric Lighting Company. The Shafer incandescent lamps are to be adopted and used, and a sufficient number will be kept in stock to keep the patrons of the company always supplied. The poles and wires of both companies will be used in common. The machinery of the old Hauss plant will furnish the electric power for the incandescent lamps, while the Brush machinery will supply the arcs. The prices of the lights will not be materially changed, the consolidation having been made for mutual protection. A general manager, a thorough expert in electrical matters, will be chosen and placed in charge of both works. The company will begin at once putting in the new and improved supporters made by the Shafer company.

The District Telegraph and Electric Company of Birmingham, Ala., has received a contract for putting up an electric light plant to light a cave near Hunterville, Ala., and have also entered into a contract to light the city of Tuscaloosa with electricity.

Another consolidation of light companies has taken place at Forth Smith, Ark., the Fort Smith Gas Light Company and the Electric Light Company having pooled their issues. This company is now making $50,000 additions to their plant. The city has ordered 125 additional street lamps. The new officers of the consolidated company are W. J. Johnson, president; George Matthews, vice-president; George Seigel, secretary; and G. T. Sparks, treasurer.

The city of Natchez, Miss., has been conferring with the Vanderpoele Electric Light Company, looking to the illuminating of the "city under the hill" with 50 lights, of 2,000 candle-power each. The stipulations are that the plant shall be erected and in full operation within three months. Leading business men of the city all favor the entering into the contract on the part of the City Council, and there are strong probabilities that the contract will be let.

Nashville, Tenn., is investigating electric motors for propelling street railway cars, and if found to be practical, they will be adopted on the lines of that city.

Johnson City, Tennessee, several nights ago was lighted for the first time by electric lights. The citizens were not expecting the lights to be turned on under several weeks, and consequently they were very agreeably surprised.

An electrical street railway company has been organized in Asheville, N. C., with Dr. S. W. Zattle, Talbot Penniman, W. R. Penniman, and Thomas A. Jones as incorporators.

The Knoxville Electric Light and Motive Power Company has been chartered at Knoxville, Tenn., by J. M. Thornburg, W. A. Simmons, and E. F. Wiley.

The electric light system of Raleigh, N.C., was inaugurated on the night of the fourth of July.

In Texas, the Tyler Electric Light Co., with a capital of $50,000, has been chartered, and at Dallas, the Queen City Electric Light Company announce their intention to erect a plant.

The De Land, Fla., Electric Light Co., discontinued business, and that town will now return to the use of oil lamps.

EDWARD A. OLDHAM.

Anniston, Ala, July 10, 1888.

Electric Clubbers' Clambake.

A number of gentlemen, members of Electric Clubs of New York and Boston, with their wives, participated in an old fashioned Rhode Island clambake at Providence, last Saturday. The occasion was specially designed for the benefit of the members of the fair sex, to whom the unique entertainment of clambakes is not common, and in this respect was an unqualified success. A boat-ride over from New York and a car-ride from Boston brought the party together in Providence, and the day was delightfully spent and the clambake hugely enjoyed.

There were several amusing incidents, but the one that was enjoyed the most by all observers, was the unlucky fall, through the breaking of a step-board, of Mr. Newark Baker into the water, from which he was rescued by gallant Fred. Boynton and plucky Geo. Porter. The sun and Geo. Manson soon dried the victims, who claimed they did not regret the accident, as it evidently furnished much fun for the others and besides gave them a new experience—all three of them for the first time tasting water.

It was voted to hold the clambake another year, and to Mr. C. O. Baker, who had so successfully planned this one, was left the matter of arrangement.

Among the gentlemen and ladies present were Col. and Mrs. C. M. Ransom, Mr. and Mrs. F. W. Harrington, Mr. and Mrs. Fred. Boynton, Dr. and Mrs. A. V. Garratt, of Boston; Mr. and Mrs. E. B. Baker, of New Haven; Mr. and Mrs. E. F. Phillips, A. C. White of Providence; Mr. and Mrs. Geo. T. Manson, New York; Mr. and Mrs. Cyrus O. Baker, Jr., of Newark; Mr. and Mrs. Geo. F. Porter, of Philadelphia; Mr. and Mrs. E. F. Peck of Brooklyn.

Telephones Burned.

In the suit of the American Bell Telephone Company against the Texas Pan Electric Telephone Company and the Pan Electric telephone companies of Forth Worth, Dallas, Denison and Abilene, in the United States Court for the northern district of Texas, decrees for the complainant have been entered by consent, and thus finally ends these famous suits in that State. Says the Dallas *Morning News:* "The last sad act was performed last week, when, under direction of Special Agent Frank B. Knight, of the American Bell Telephone Company, nearly 2,500 of the old pan electric telephones, which, under the agreement, had been surrendered, were carried to the dumping ground north of the city of Dallas and consigned to the flames. There were cherry and rose-wood boxes by the hundred, which, although they represented an outlay of many thousands of dollars, could not be utilized by the Bell Company, and consequently were of no use to any one.

"It is understood that the terms offered by the Bell Company upon which the final settlement was based were sufficiently generous as to leave no feeling of bitterness or hostility in the minds of those interested.

"The poles and wires of the defunct company have been sold to the new electric light company of Dallas."

ELECTRIC LIGHT NEWS

—— The town of Alemeda, Cal., pays $439 per month for electric lighting.

—— R. P. Valentine has been appointed superintendent of the Pasadena, Cal., Electric Light and Power Co.

—— Mr. C. E. Burrows, of the Walla Walla Gas Works, Washington Territory, will add an electric plant.

—— The city council of Detroit, is anxious to have the incandescent light in its chamber. The members have finally become tired of gas.

—— The Electric Improvement Company, San Francisco, Cal., have wired the Hotel Vendome in San Jose for a 200-light incandescent plant.

—— The Thomson-Houston Electric Light Company is putting in a 40 horse-power Payne engine, to run the electric Plant at White Plains, N. Y.

—— The Spokane Falls, W. T., have ordered a new fifty-light dynamo to fill new orders for both arc and incandescent lights for town and private consumers.

—— The Electric Improvement Company, San Francisco, Cal., will put up a plant for lighting the town of Willows. The Mather incandescent and the American arc will be used.

—— The Pacific Rolling Mills of San Francisco, Cal., has been lighted for some time by electricity, with such satisfaction that they have added ten arc lamps. They use the American system.

—— The Electric Improvement Company, of San Francisco, Cal., is making arrangements for lighting the towns of Santa Clara and San Jose. The American system of arc and the Slattery incandescent will be used.

—— San Diego, Cal., has adopted the Westinghome system of incandescent light and the plant has been ordered. The capacity will be 1,300 lights, and it is expected the town will be lighted about October 1st.

—— A correspondent at Amesbury, Mass., says: The electric light company intends to remove its plant in the near future to a fireproof building near its present location. It has now one of the finest dynamo rooms in this section.

NEW CORPORATIONS.

Jersey City.—The Electro Dissolvent Co., Jersey City; capital $50,000. Geo. F. Gantz and others, incorporators.

Chicago, Ill.—The Fowler Insulating Co., Chicago, Ill.; capital $150,000. Preston B. Rose and others, incorporators.

Ellensburg, W. T.—Ellensburg Light and Power Company; capital stock, $25,000; incorporators, J. A. Shandy and others.

Whatcom, W. T.—The Bellingham Bay Telephone Company, of Whatcom; capital stock, $20,000. C. W. Carter, P. E. Dickinson, Geo. Nolte, incorporators.

Pueblo, Col.—The Pueblo Fuel, Gas and Incandescent Light Co. has been incorporated; capital of $100,000, and a plant is to be established. D. Miller and others, incorporators.

San Francisco, Cal.—The Harding Electric Manufacturing Company; capital stock, $1,000,000; subscribed, $71,300; incorporators, O. W. Nordwell, J. B. Roby, G. W. Chandler and others.

Charleston, Ill.—The Charleston Brush Light Company of Charleston: capital, $15,000; to deal in motor and electric apparatus and to operate motor and electric plants; incorporators, E. L. Link, E. Cadle, and C. E. Winter.

Philadelphia, Pa.—The Werts Sheet Metal and Glass Company has filed a certificate of incorporation. The capital stock is $250,000, of which $20,000 is paid in. The incorporators are Henry Wattson, of Philadelphia; William Werts, James E. Hays, Samuel Hufty and George H. Gilkey, of Camden.

Telephonic News

*** Telegraphic communication has been established between San Diego and Ensenada and Todos Santos, Lower California.

*** The Bellingham Bay Telephone Co., of Whatcom, W. T., will erect and operate telephone lines throughout Whatcom, Skagit, Shohomish, King and Pierce counties.

*** A telephone has been fitted up between the Hospice on the Great St. Bernard and the valley below, and the monks are now informed when travellers start to ascend the pass. If they do not appear within a proper time servants are sent to meet them.

*** The Metropolitan Telephone & Telegraph Co's 5 per cent. gold bonds, which are offered by the banking house of Lee, Higginson & Co., are a first mortgage and beside being safe, should be a desirable investment to those who are already largely in railroad bonds, as these will be good whether crops are good or bad, large or small.—*Boston Commercial Bulletin.*

*** Glasgow has a system of automatic telephone call boxes. There are seventy-six of the boxes scattered about the city, and every subscriber has a key to them. A non-subscriber wanting to use them must first ring up the exchange and ask if the connection he desires can be made. If it can, he drops the fee which is either 3 pennies or 6, according to the distance he wants to talk, into a hole in the box. The pennies as they fall break a circuit and a ring a bell at the central office. When the bell has rung the required number of times, the central office makes the connection. At the end of the three minutes allowed for conversation the connection is broken automatically. The average time taken to put two persons in telephonic communication in Glasgow is 35 seconds; in Birmingham, 40; in Liverpool, 32, and in Dundee, 20. This was ascertained from the results of ten calls in each town.

*** The recent action of the Bell Telephone Company in removing all the telephones from the City Hall, St. Louis, excepting that in the Council Chamber, has had the effect of greatly increasing the work of Secretary Taaffe and Assistant Secretary McDonald of that branch of the Assembly, says the *Globe Democrat*. Before the company began removing the telephones at the expiration of contracts, there were 'phones in the Mayor's office, House of Delegates, Register's office and Water Rates office. The calls were well distributed among the five 'phones, but as it is now, the Council instrument bears the whole brunt of the telephonic work of the City Hall. No matter what department is wanted, the Council is rung up, and the secretary or his assistant are informed that the person at the other end of the wire wants to converse with such and such an official. Yesterday Assistant Secretary McDonald, although very busy attending to Council business, made about a dozen trips through the building to notify different officials and clerks that they were wanted at the telephone. This would not be considered such a hardship by the secretary and assistant secretary if it occurred only occasionally, but as it happens every day, they are becoming tired of it, and are anxiously waiting for the replacement of the boxes that were removed during the recent warfare between the company and the city. Comptroller Campbell has not yet requested the company to replace the boxes, and if he does he says that he will not sign any supplementary contracts to pay, as the telephone directors require. It seems to be the impression that the city will make no more telephone contracts until the validity of the ordinance reducing the rate to $50 per annum is passed upon by the Supreme Court.

Railway Telegraph Superintendents.

THE ANNUAL MEETING OF THESE TALENTED SPECIALISTS.

The Murray Hill is a handsome and elegant New York hotel, and last week was honored with the presence of the Superintendents of Railway Telegraph, an alert and energetic body of men who have come to the front in the years since Morse made his discovery, and who have great responsibilities in connection with the train and commercial service of the United States. As the list of attendants shows, the gentlemen came from all parts of the country—it is not difficult, we all know, to find business in New York at least once a year—and they came together as was evidenced throughout the proceedings, to discuss ways and means for advancing the telegraph profession as applied to their field.

If we mistake not, the first of these gatherings was brought about by the Hon. Charles Selden, now of Baltimore, at that time with the Wabash, and he has had the satisfaction of seeing his first work fructify into a permanent and valuable organization. The REVIEW is pleased to state that it has endeavored at all times to assist in this work, and was pleased to hold up Col. Selden's hands at a time when the success of the organization was yet undecided.

The first meeting was held in a convenient parlor of the Murray Hill Wednesday forenoon, July 11th. Telegraph Superintendent Lang, of the New York and New England Railway, presided with the grace and ability of one accustomed to the gavel. Routine business was pushed through pretty lively, the members having decided to leave the matter of discussions until the following day. A brief discussion in relation to time signals was indulged in. The REVIEWITE, while this was going on, was privately informed by Judge C. W. Hammond, of St. Louis, and Hon. H. C. Sprague, another Missourite hailing from Kansas City, that they got their time signals from the Washington University, St. Louis, and they were dead right on time once every day. This same university (which they protested should never be confounded with the ordinary one at Washington, D. C.), supplied fresh, cool time every day to a number of other roads, thus keeping them all happy.

Col. C. E. Topping announced a boat ride to Glen Island, tendered the Association by the Hon. Jno. A. Starin. Unanimously accepted, and some of them wanted to start at once. It was finally decided to go at 3 o'clock, and they all went.

Col. Topping also announced that Benjamin Orton, vice-president of the Long Island Railway Company, has tendered free transportation in special cars to Manhattan Beach for Thursday evening. This was accepted without a dissenting voice.

THURSDAY'S MEETING.

There was a good attendance during the forenoon, and business was quite rapidly despatched.

The election of officers for the ensuing year resulted as follows:

President—G. C. Kinsman, of Decatur, Ill.

Vice-President—C. A. Darlton, Washington, D. C.

Secretary and Treasurer (re-elected)—P. W. Drew, Chicago, Ill.

Atlanta, Ga., was selected as the place to meet next year, and the third Wednesday in October selected as the date.

The committee appointed two years ago, and then continued and added to, which was to consider the question of a change in Morse alphabet, made a report to the effect that they were unable to decide on any change that would meet with general approval. The committee was therefore discharged.

Mr. Chas. Selden, who though suffering from a slight attack of that aristocratic complaint the gout, was still able to work for the best interests of the Association, moved that a committee of five be appointed by the presiding officer (Mr. Kinsman) to receive and disseminate valuable information. The motion prevailed, and Messrs. M. B. Leonard, J. W. Lattig, Geo. E. Simpson, Adonis R. Swift, and T. J. Higgins were appointed.

A committee of three was also appointed to arrange a programme of papers and addresses for the next meeting. Messrs. E. M. Herr, Chas. Selden and Geo. L. Lang were appointed.

Messrs. Selden, Lang and C. W. Jones were appointed a committee to draft resolutions of thanks to the railroad, steamboat and other companies and persons who had so courteously extended favors to the Association at this meeting.

A vote of thanks was tendered the exhibitors of electrical appliances, and Secretary Drew was requested to record a brief description of all exhibits.

The Association then adjourned to the exhibition room.

In the evening they went in a body to Manhattan Beach.

LIST OF ATTENDANTS AND SOME CONVENTION NOTES.

The names of the gentlemen in attendance and the roads with which they are connected are given below:

Geo. L. Lang, Boston, N. Y. & N. E.; G. C. Kinsman, Decatur, Ill.; Wabash; A. R. Swift, Chicago, C., R. I. & P.; P. W. Drew, Chicago, Chicago & E. Illinois; C. W. Hammond, St. Louis, Missouri Pacific; Chas. Selden, Baltimore, B. & O.; G. E. Simpson, Milwaukee, C., M. & St. P.; E. M. Herr, Chicago, C., B. & Q.; M. B. Leonard, Richmond, Va., N., N. & M. V.; C. S. Jones, Chicago, Illinois Central; Geo. T. Williams, Cleveland, N. Y., C. & St. L.; T. J. Higgins, Cleveland, C., C., C. & I.; H. C. Sprague, Kansas City, K. C., Ft. Scott & M.; C. E. Topping, Long Island City, Long Island; J. W. Lattig, Mauch Chunk, Pa., Lehigh Valley; J. B. Gibbs, Sedalia, Missouri Pacific; H. F. Houghton, Butler, Ind., Wabash; S. S. Bogart, Weehawken, N. J., West Shore; I. Cohen, Houston, Tex., H. & T. C.; W. J. Holmes, New York, Erie; C. A. Darlton, Washington, D. C., R. & D.; E. A. Smith, Boston, Fitchburgh.

In addition to these, the following named gentlemen, nearly all of whom were present, were elected members:

N. B. Patterson, Mattoon, Ill., P. D. & E.; R. Stewart, Elizabeth, N. J., C. R. R. & N. J.; F. W. Wilson, Ft. Wayne, G. R. & I.; J. E. Duval, Ottawa, Ont., C. A.; W. B. Blanton, Dubuque, Ia., C., St. P. & K. C.; J. A. Lockard, Atlanta, Ga., R. & D.; Horace Johnson, Chillocothe, C. W. & B.; J. Stenson, Long Island City, Long Island; F. P. Cummings, New York, N. Y., N. H. & H.; J. G. Pinkerton, Amoy, Miss., K. C., M. & B.; C. H. Hopkins, Norwich, N. Y., O. & W.

There were a number of interesting exhibits by E. S. Greely & Co., the Western Electric Company, and other manufacturers. T. Jarrard Smith represented the former company, and the handsome F. H. Wilkins the latter.

The Geneva Non-magnetic Watch Company had a very fine exhibit of their watches, and the railroad men took great interest in this late and most valuable improvement in timepieces.

J. W. Godfrey was the only insulated wire man present. He distributed samples of the "Grimshaw" and other samples with noted prodigality.

The Waters-Sweeny Telegraph and Telephone Switch Company, of Terre Haute, Ind., exhibited a number of their electrical appliances.

Street's Railway Signal was exhibited by J. C. O'Neil, of Cleveland. A number of other signaling appliances were exhibited.

The Western Electric Company made a special exhibit of the "self-starting automatic register" for train despatchers' wire.

Mr. C. E. Topping, formerly superintendent of telegraph and express on the Long Island Railway, has been called to a more important and extended field outside of the telegraphic service, was elected an honorary member—the first in the history of the Association.

Adonis Raphael Swift, of the Rock Island, again carried off the honors for physical beauty. Selden would have crowded him, only he had the gout. As it was, Simpson, of Milwaukee, was awarded honors next to the head.

C. E. Topping and S. S. Bogart were the gentlemen who saw that the visit of the foreigners was made pleasant. They seemed to know just what telegraph men liked.

An electric train cord was to be seen in the exhibition room, the invention of Mr. Chas. Selden. It is so arranged as to operate the bell electrically or mechanically. It was exhibited by the Chicago Combined Electric Bell Company.

A semaphone signal, known as the Selden-Ott signal, was exhibited. It gives three colors and three conditions with one lever, and shows to the operator the position at all times of the signal. This semaphone system has been adopted by the B. and O. Railway on the entire system.

During the last day's work of the Association, Mr. J. W. Lattig, of the Lehigh Valley Railway, described the very satisfactory service given his company by the new induction telegraph system, and answered a number of questions asked by interested superintendents. The fact that during the heavy snowstorm last winter the Lehigh Company depended entirely on the induction telegraph for its signals was noted as quite a point in its favor.

Friday after the adjournment was spent in investigating a new signaling system on the West Shore Railway and the induction telegraph on the Lehigh Valley Road. The visitors were handsomely entertained on both roads.

The courtesies of the Club House of the Electric Club was tendered the Association, and a number of the superintendents paid the Club a visit. Several of them are already members of the Club.

Electric Club Notes.

John H. Stevenson, pay inspector of the U. S. Navy, has the honor of being the first life member in the Electric Club, N. Y.

New copies of the Constitution and By-Laws, containing the names of officers and members, are being printed and will be at the club for delivery to members early next month.

No better *table d'hote* dinners for the money are served in the city than those at the club. Thursday evenings, and evenings when the managers meet, are the occasions of these excellent meals.

The electrical fraternity of Kansas City, Mo., that very enterprising Western city, are discussing the question of an electric club, where they could have the conveniences of a club-room and all become better acquainted. There is a constantly growing list of electrical workers in Kansas City.

Personal.

The Electrical Accumulator Co. have secured the services of Mr. William Hood as traveler.

Mr. H. H. Eustis, electrician of the Eastern Cable Co., Boston, was a New York visitor last week.

Mr. Geo. W. Walker, formerly with the electric lighting company of Bethlehem, Pa., has accepted a responsible position with the Electrical Accumulator Company, and will make his headquarters at 44 Broadway, New New York.

*** The Southern New England Telephone Company has issued a "Manual" dated July, 1888, in neat book form, comprising 30 pages. Offices are divided into four classes, class 1 signifying offices of more than 400 subscribers; exchange hours, repair hints, rates of local and long distance service, and many other valuable features are comprised in this little book.

*** A dispatch from Chicago, July 5, says: The almost total paralysis of the telegraph service west of Chicago to-day indicates apparently that the storm of the past few days culminating last night was one of the most widespread and severest in a number of years. A great net work of wires covers the territory stretching to the Rocky Mountains, but so few of the hundreds of lines running in all directions are this morning in anything but a workable condition that business with points west of here is comparatively at a stanstill.

Electric Railways.

(*Continued from page 3.*)

top of a grade, the faster a motor runs the better. It has not got to be held in to save it.

The riding of an electrical car is far easier than that of any cable or horse car, starting and stopping more easily, and being in a large measure free from lurching and oscillation. The cars are much cleaner. They can be brilliantly lighted, and they can be heated by electricity. There is no dust such as arises from the heels of horses. The sanitary conditions are entirely altered, and the health and comfort of the whole population is conserved. Stables with all their unsavory characteristics and the consequent depreciation of the value of adjacent real estate disappear. No sand is needed on the pavements, and the pavements are not so quickly worn out; often no centre paving is necessary. It becomes feasible to operate branch lines, and also combinations of grades, curves, and ill conditioned streets which would be prohibitory to any other system. It is not to be claimed that any one system of electric traction has all these advantages; but in some form or other they will be found.

It has been said that an extended system cannot be operated by electricity, that the lines may break down, that a large number of cars cannot be operated simultaneously, especially when bunched up, that wires burn out, that brushes burn up.

True, these things have happened, and in case of defective workmanship or carelessness they may happen again. Although electricity is a force of unknown nature, and we know it by its effects, it is folly to hold that whatever faults in machinery may exist or accidents occur do not come within a very narrow and limited category; and powerful and mysterious as it is, and answering an impulse with the rapidity of lightning, it is at the same time the most tractable and law abiding agent with which we have to deal.

There is not a freak of which it is capable which we cannot guard against. It has not an attribute of which we cannot make positive use. It has no power of damage which cannot be controlled.

The development of its application, the mistakes which have been made and the accidents which have occurred are but the milestones and guideposts of the highway to success.

Were it not for the occasional failures there could be no advance.

As a matter of fact there is no apparatus for the transmission of energy that compares in simplicity and efficiency with the dynamo-electric machine and the electric motor. There is no machine in existence which, when thoroughly and well built and decently cared for, is less liable to get out of order, and will stand harder usage and greater variations of work with a minimum of attendance and care. A motor has but one moving part, and that has a rotary motion. Its torsional effort under given conditions is a constant, and when properly built and proportioned some types have over a wide range the remarkable and unique quality of having this torsional effort vary as the square of the current used, a feature of marked importance in traction work.

As modern as the motor is, the peculiarities of all its phases are just as well known and capable of just as graphic representation and forecast as are those of the steam engine. This can best be shown by reference to some curves which illustrate the characteristics of some of the Richmond motors, and have the same significance that an indicator diagram has for an engine (see Fig. 4).

For convenience, these curves are plotted on both sides of the axis of X. The ampere turns on one leg of the field magnet are plotted as abscissæ. The curve, $O\ A$, gives the characteristic of the machine when run as a series dynamo on a variable external resistance at 856 revolutions. $B\ C$ represents the equation of counter-electro-motive force, with an initial electro-motive force of 400 volts. I have allowed an increase in the actual resistance of the machine of 10 per cent. for heating and other causes. The speed of the armature, the miles per hour made by a car with the Richmond gearing, the tractive effort in pounds for one motor, and the horse-power units are, for convenience, all laid off as negative ordinates. Equal units of horse-power and torque are laid off as abscissæ, so as to make the maximum points coincident.

The first important curve which we have to get is the speed of the motor in terms of its current. We have the law that the speed is directly proportional to the counter-electro-motive force developed, and inversely proportional to the strength of the field. In other words, the speed curve, $E\ D\ C$, in terms of the current, is plotted from the curves $O\ A$ and $B\ C$, and the speed for any current is found by multiplying 856 revolutions by the ratio of the ordinates corresponding to that current. The next curve with which we have to deal is that of the work of the motor in terms of the current; that is, the curve $O\ F\ C$, which intersects the axis of X, and at the same point as the curves of speed in terms of the current and the counter-electro-motive force.

A third and most important curve is that of the work of the motor in terms of its speed, which is the curve $O\ D\ G$, plotted from the curves $E\ D\ C$ and $O\ F\ C$, with the horse-power units transferred to the axis of X as abscissæ. For instance, following the negative ordinate for 30 amperes, we find, at the proper intersection, a speed of 630 revolutions of the armature, or 4.82 miles per hour of the car; and, at the intersection of the work curve, that 11.65 h. p. is developed. These two values give us the point S as one of the points of the work curve, and so on.

Referring to the work required to be expended on a car we have from the formula—

$$\text{h. p.} = \frac{w\ n}{335}\left(\frac{k}{2000} \pm \sin\ \Theta\right)$$

where w = wt. in lbs.,
n = miles per hour,
k = resistance to traction in lbs. per ton on level.
o = angle of grade,

cent. grade at 4.82 miles per hour, and each motor would take 30 amperes of current. If the grade or weight were increased, the curve $O\ N$ would be carried toward $O\ M$; or, if the ratio of gearing is changed, then, with the curve $O\ N$ in its fixed position, the weight of car or grade could be increased, although the speed of the car would be reduced. Other curves are shown, $L\ K$ showing the tractive effort of the motor in the terms of its speed, and $O\ H$ showing the tractive effort in terms of the current; the tractive effort varying, of course, as the work divided by the speed.

The variety of problems which can be worked out from these curve sheets is very large, and they become of vital importance in dealing with any new work. Nothing could show more clearly the value of a mass of iron in the field magnets (as I have always held to be the proper method of building motors), and the exceptionable qualifications of motors for tractive purposes. Any change in the switch or any change in the potential will vary these curves materially. One fact, however, is to be noted; no matter how the field may be changed, the speed of the motor at 50 per cent. efficiency is a constant.

The connection of the motor to the driving wheels has been attempted in a great variety of ways, and nearly every mechanical device possible has been used. Often the motors are carried upon the car body and connection made with the wheels, which should bear a variable position relative to the car, by means of friction wheels, sprocket-wheels and chains, or by belts, ropes or wire-chains with tightening devices. The motor armature has been mounted directly on the axle, and also hung on a frame between the axles, being connected to both wheels by cranks and side rods, necessitating equal speeds of revolution of the motor armature and the wheels.

These methods are all crude and unsatisfactory. They are makeshifts and ignore the most important and essential facts which have been developed in car and motor construction. There is to my mind only one good way to connect a motor, and this is to centre the motor upon the axle, supporting it flexibly from the car body or the car truck, and driving by gearing, with one or two reductions according to the service which is demanded. This is the only way in which an absolutely safe and positive connection can be depended upon, both for ordi-

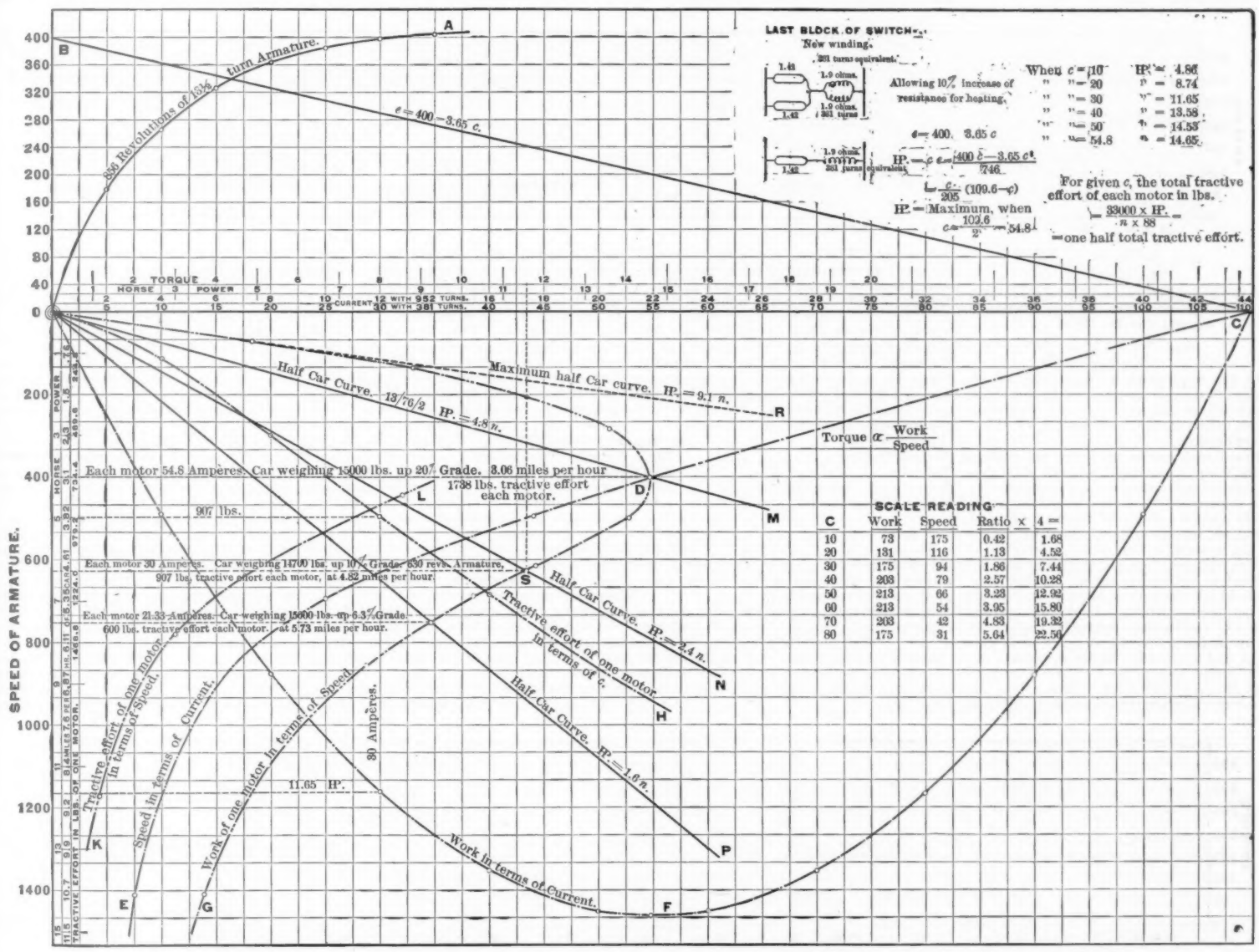

LAST BLOCK OF SWITCH.
New winding.
381 turns equivalent.
1.43
1.9 ohms.
381 turns
1.42
Allowing 10% increase of resistance for heating,
When c = 10 HP. = 4.86
" " = 20 " = 8.74
" " = 30 " = 11.65
" " = 40 " = 13.58
" " = 50 " = 14.53
" " = 54.8 " = 14.65
e = 400 − 3.65 c
HP. = c e = 400 c − 3.65 c²/746
= c/205 (109.6 − c)
HP. = Maximum, when c = 102.6/2 = 54.8
For given c, the total tractive effort of each motor in lbs. = 33000 × HP./n × 88 = one half total tractive effort.
A
B
C
856 Revolutions of 15¾ turn Armature.
e = 400 − 3.65 c.
HORSE POWER
TORQUE
CURRENT WITH 952 TURNS. WITH 381 TURNS.
SPEED OF ARMATURE.
TRACTIVE EFFORT IN LBS. OF ONE MOTOR.
Half Car Curve. 13/76/2 HP. = 4.8 n.
Maximum half Car curve. HP. = 9.1 n.
R
Torque ∝ Work/Speed
Each motor 54.8 Amperes. Car weighing 15000 lbs. up 20% Grade. 3.06 miles per hour
1738 lbs. tractive effort each motor.
D
L
M
907 lbs.
Each motor 30 Amperes. Car weighing 14700 lbs. up 10% Grade. 630 revs. Armature,
907 lbs. tractive effort each motor, at 4.82 miles per hour.
S
Each motor 21.33 Amperes. Car weighing 15000 lbs. up 5.3% Grade.
600 lbs. tractive effort each motor. at 5.73 miles per hour.
Tractive effort of one motor. In terms of Speed.
Speed in terms of Current.
Work of one motor in terms of Speed.
90 Amperes.
11.65 HP.
Half Car Curve. HP. = 2.4 n.
Tractive effort of one motor. In terms of c.
N
H
Half Car Curve. HP. = 1.8 n.
P
Work in terms of Current.
K
E
G
F
SCALE READING
C | Work | Speed | Ratio x 4 =
10 | 73 | 175 | 0.42 | 1.68
20 | 131 | 116 | 1.13 | 4.52
30 | 175 | 94 | 1.86 | 7.44
40 | 203 | 79 | 2.57 | 10.28
50 | 213 | 66 | 3.23 | 12.92
60 | 213 | 54 | 3.95 | 15.80
70 | 203 | 42 | 4.83 | 19.32
80 | 175 | 31 | 5.64 | 22.56

FIG. 4.—DIAGRAM OF CURVES, RICHMOND ELECTRIC ROAD, ILLUSTRATING MR. SPRAGUE'S PAPER. For other Diagrams see page 8.

nary work and for the normal and sudden strains called for in an emergency.

Properly made, the friction of this method of reduction is very low, the motion is smooth and free, and reasonably noiseless.

The proposition to couple the motor so that is shall make the same number of revolutions as the axle, ignores one of the most important points which makes light weight in motors possible, and that is the high speed at which the armature can be run.

I have pointed out, in describing the curve characteristics of a motor, one of the essentials to determine the proper ratio of reduction for any motor when required to do a given work. I may here add a brief formula, which will also serve as an index in this matter: Let f equal the maximum velocity in feet per minute at which an armature at any time is allowed to travel; n the number of miles per hour to be made by the car; D the diameter of the car wheel in inches; d the diameter of the armature in inches. Then the ratio of the gearing must be expressed by the equation.

$$R = \frac{88\,f\,D}{n\,d}.$$

For instance, let $f = 4{,}000$, $n = 12$, $D = 30$ and d 10, about the values which exist in street car work. Then

$$R = \frac{4{,}000\times30}{88\times12\times10} = \frac{125}{11}$$

and this should be made in two reductions. As in our largest trucks, let $f = 4{,}000$, $n = 35$, $D = 42$, and $d = 18$. Then

$$R = \frac{4{,}000\times42}{8\times35\times18} = \frac{100}{33}$$

In the application of electricity we are limited to no one system; we have a choice which will permit us to meet any exigencies or conditions of traffic. There are two kinds of application.

In one each car is perfectly independent of the other, receiving its charge at the central station and acting as an individual unit. The storage battery method is such a system.

The other is a system of direct supply, and, unlike the battery system, where the energy of the system is four times converted, it suffers only two losses. In this system the current is delivered directly to the line, from which the motors as they move along derive their current. There are several forms of conductors—centre and side rails, the main tracks, conductors carried in conduits, and overhead. Either a complete metallic circuit may be used, or one conductor with the rail and earth return. The machines can be operated under three different systems—the series, multiple series and parallel circuit distribution.

Of these various plans I shall discuss only three—the storage battery, the conduit and the single overhead wire system, with underneath contact carried on the car, and for the systems of distribution the parallel circuit system only.

The storage battery, from the time of its first introduction to the public, has offered a tempting solution to the application of electricity for surface transit. The great advantage of the battery system is, that while most of the advantages of an electric system are retained, such as perfect control of the car, ease of manipulation, cleanliness, and so forth, each car in itself becomes an independent unit, not dependent upon any general accident to a system. As attractive a solution as the storage battery at first sight seems, there are many points of disadvantage in its present state of development. One of the most important is the excessive weight of battery which is necessary under the conditions of service which are met with in this country, from 3,400 to 4,000 pounds being the ordinary weight. Not over 10 per cent. of the lead in these batteries is actually used for storage. On account of the weight and the room which the battery takes up, there has to be a radical change in the construction of the cars, and while old cars can be made use of by a great deal of patching, it is not advisable to attempt this. This change makes the present cars useless, and likewise increases the cost of new car bodies.

Then again, while the tracks as they exist may stand the additional weight of motors on a four-wheel car, the additional weight of battery, making the total weight on a given wheel-base double what it was before, will render it necessary on a great many tracks to relay the road-bed, or to put in 8-wheel cars. Of course these objections are not so serious on a new road as they are on an old one.

But I confidently expect to see, in the not so very distant future, the weight of battery necessary to handle a car reduced one-half; this, besides overcoming some of the objections which exist now, will halve the expense of handling them at the central station, and will also allow the present standard width of aisle to be maintained.

The present excessive cost and unknown depreciation of the battery, its lack of efficiency, limited capacity, the fact that only a portion of the charge can be taken out with safety, and the reduction of its output when sudden demands are made upon it, are all of such a character as to leave wide room for improvement. The loss of efficiency in conversion I do not esteem of such vast importance, because, in any large system where the engines are kept going under a steady load, the cost of operation will not be so very much more than where operating under continually varying loads. The limited rate of discharge, as well as the limited capacity, limits the grade work to which a battery car can be subjected. For instance, as batteries and cars are now made, we can easily have the following combinations of weight.

	Pounds.
Weight of car	5,000
Batteries	3,600
Motors and other apparatus	2,000
Sixty-five passengers	9,100
Total	19,700

To start and to accelerate this load on, say, a six per cent. grade, demands a discharge rate which no storage battery company cares to recommend.

As near as it is possible for us to get at a correct estimate on a new road of moderate grades, a storage battery system could be operated at about 80 per cent. of the cost of operation by horses. This is about double the cost of the direct system of supply on a large scale.

But the storage battery is not going to stand still.

Many men with abundant capital are striving for improvement, and I think there is but little question that batteries will be reduced in weight, increased in capacity, and made far more efficient and long-lived.

The conduit and overhead systems have one point in common. Both are dependent upon a central station, and the actual cost of operation (except for the care and maintenance of the conduit itself) would be about the same. There is, however, a great difference of investment. Both must have about the same amount of copper, and, to be effective, about the same distribution.

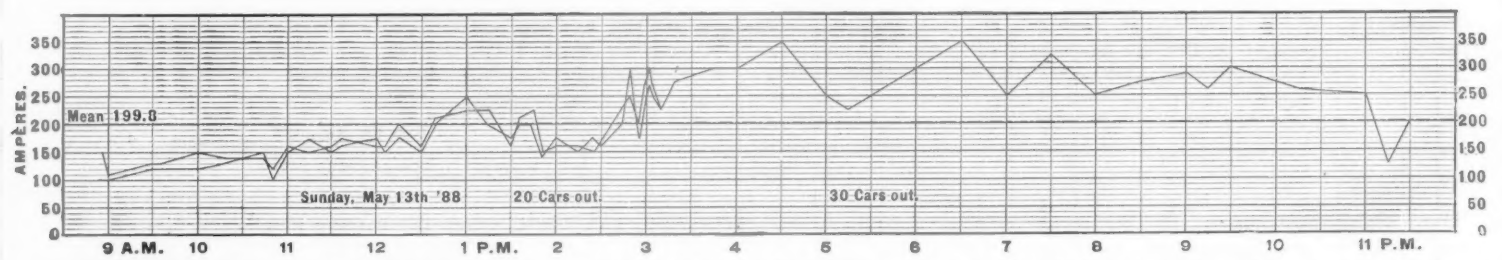
The difference of cost then is practically the difference between pole erection and conduit laying, and this will be from $25,000 to $30,000 per mile. As an investment of course it means that with the conduit very much more money has to be earned. The electrical conduit can be built for less money than a cable conduit, because it can be made of less depth, but it cannot be built without due regard to the strains of street traffic and weather, and with proper drainage and cleaning facilities. The advantages of the conduit are chiefly that there are no overhead obstructions. Its disadvantages are, besides its great cost, the lack of cleanliness, increased possibilities of leakage, and greater difficulty of repair in case of accident. Recognizing, however, the demand which exists in certain places for a conduit, we have developed such a system which has many of the same elements of simplicity and reliability that our overhead system possesses.

The working conductor carried in the conduit is divided into sections, which at intervals of every block or half block, as desired, are connected through automatic cut-outs in manholes to the main conductor, which is continuous and enclosed in a lead or iron covered cable. Any accident to a section, such as flooding, short circuiting, and so forth, will simply cut out that particular block.

For the immediate solution of the question of more rapid and cheaper transit in many places the overhead system is most available.

I am aware that a great hue and cry has been raised, especially of late, against any electric wires whatsoever being used above ground. The feeling which exists is not entirely unreasonable; in fact it is easily accounted for by the most casual inspection of the condition of the wires of this city. But many of the objections which are raised against all overhead systems are not necessarily inherent; they are very largely due to gross carelessness in construction engendered by a faulty municipal administration. We have in our cities little or no active control or oversight of the wires which have been put in our streets. Year after year, from the earliest telegraph days, those in control have granted to telegraph, electric light, telephone and electric power companies innumerable more or less limited franchises for stringing or hanging wires through our streets. These permits have often been granted without any restriction whatever; they are often granted for a "consideration." The erection and maintenance of these lines being a large factor in the cost of construction and operation of the companies, they have been put up with little or no regard to public convenience or safety—certainly with no regard to any æsthetic tastes—and oftentimes with an utter ignorance of the proper methods of construction. Fire-underwriters, in their wisdom, have demanded an insulation to stand fire, forgetting, or in apparent ignorance of, the fact that protection from moisture and leakage is of far more vital importance. Hence we have that treacherous wire known as "underwriters' wire," or more commonly among electricians, "undertakers' wire."

The poles have, until lately, been of the



In all improvements for public improvement we have to consider the arguments for as well as against such improvements. It is not sufficient that we say that there are disadvantages attending the introduction of the system, we must consider likewise the possible advantages; and this is especially important when we consider the use of the overhead line in a system for propelling street cars. Such a line being part of an investment of a company which has practically no competition on its own streets, and whose own interest would require it to keep its line in first-class condition, can be put up in a manner presenting few of the objections which are generally urged against a system of overhead wires. I would not urge its adoption for all places, but in all suburban districts; for comparatively narrow streets, for all streets operating under an elevated railway structure, or where the tracks are near a sidewalk, the direct system of supply from an overhead line with underneath contact, presents advantages which, once appreciated, far outweigh the possible objection of such a system.

Several methods exist in which the wires can be erected. One in which span wires, at a distance of 125 feet apart, reach across the street from building to building, or from pole to pole, and has suspended from it, directly over the track, at a height of about 19 feet, a longitudinal wire of not more than a quarter of an inch diameter, this wire being termed the "working conductor." This should be of the very strongest character. It should have a high elastic limit, great tenacity, and resist corrosion and oxidization.

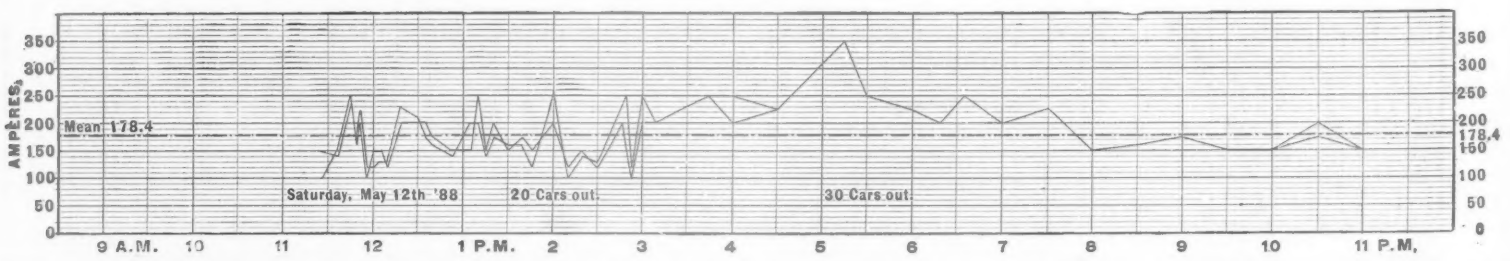
Its conductivity is a matter of less importance, since not upon it, but upon the main conductor which supplies it, do we depend for the main transmission of our current. Hence the elements of strength and reliability are of far more importance than conductivity. We have found that the best wire for this purpose is that alloy known as "silicon bronze"—a wire which can be drawn for a tensile strength of from 75,000 to 150,000 pounds per square inch; that is a strength higher than that of the best commercial steel. Such a wire it is almost impossible, under conditions of service, to break, and its life is very long. Samples of hard drawn copper wire, which possesses only from one-third to one-fifth the tensile strength of this wire, show, after months of the severest usage, scarcely any signs whatsoever of abrasion or reduction in size. This wire is of the same size whatever the distance run or the number of cars operated, and the main conductor may be stretched along the buildings, through a side-alley, along poles, underneath the elevated structure, or buried underground.

In the latter case there would be in a single-track street only one longitudinal wire, and that one over the track, and it would be no larger than a single telegraph wire; and in the case of a double track, there would be only two wires stretched longitudinally along the street, and these would be as taut as harp strings.

Switches and cut-outs are put in main and working conductors in such a way that the different sections can be operated independently, and cut out automatically or at will.

The span-wires can be as much above 19 feet from the ground as is desired. Of course, where a telephone or electric light line crosses the street, and may break and fall upon such a conductor, it would be necessary to have one or two guard wires above it.

These guard wires can be very properly carried from the span wires themselves. Furthermore, if desired, the stretches between the span wires where the guard wires are used can be very much longer than 125 feet; they can be even as long as 500 or 600 feet—that is, two or three city blocks—in which case the two guard wires form a light suspending structure, from which, at inter-



vals of a hundred feet, the middle wire is carried in a straight line.

In very many cases it is unnecessary to have any span wires whatsoever. In those streets where the track runs near the curb a light pole with an ornamental bracket is all that is necessary.

In a broad street where the tracks occupy only a small portion of the street, and are near together, a line of poles of ornate design with light arms projecting on either side can follow the centre of the street. Oftentimes there is a middle division or park, such as exists on the Boulevard in this city, which will afford space for the poles without intefering with anything.

These same poles can be used for lighting the street.

On streets occupied by elevated railroad structures, the structure itself can be used as a support for the overhead wires.

Among the numerous places in New York where an overhead system could be put in perfect operation are Eighth avenue, from Fifty-ninth street up; the Boulevard, from Fifty-ninth street up; a part of the First and Second avenue lines; the Third, Sixth and Ninth avenue lines, and all the suburban extensions in the annexed district.

To avoid any extra strain on this wire, the work continually with the current on the line. I have never known a constant potential current of 400 volts to cause of itself the death of or serious injury to a human being.

The past year to me has been one of great responsibility and wide exerience. It has been a hard year. But the experience and expense are as nothing compared with the great value of having been with my associates instrumental in bringing to a successful issue one of the most important pieces of electrical engineering with which I have ever had anything to do. Among the roads which we have equipped the most important is, of course, the Richmond Union Passenger Railway, which now has six times as many machines in operation as any other road of its character in existence, at which every difficulty to be encountered in an overhead system on heavy grades and with sharp curves has been made, and which has for all time conclusively settled the question of the economical operation of a large road by the method of direct supply.

I will briefly refer to the road, giving some illustrations of its principal features, and some facts about its operation.

Some idea of the character of the road may be gathered from the following: The total trackage is about twelve miles. It runs a very district across the Richmond, Fredericksburg and Potomac Railroad, and after several sharp curves extends back a further distance of two miles to a second car house beyond the new reservoir. Two branches connect with its main line, one leaving at the old Market Place crossing, and paralleling the Chesapeake and Ohio Railroad, and terminating at its machine shops. The other runs into what is popularly known as "Africa," a section almost exclusively inhabited by colored population.

The narrow streets, their hilly character, and the lack of paving, especially in the new districts, has made the road one of exceptional difficulty to operate. There are no less than twenty-nine curves, requiring bent rails, the majority being of sharp radius, five being less than thirty feet. There are also several sweeps or curves of large radius, several turnouts and cross-overs. The grades are the maximum ever ascended in practice by a self-propelled car depending on track adhesion alone, and many of these grades are very long. Going east there is one section of almost continual ascent for about 5,600 feet, with grades varying from three to seven per cent., and going west there is a stretch of 1,900 feet, with grades varying from three to ten per cent.

terprise has been regarded by this doubting element is somewhat significant. When the franchise was originally secured, the city was blest by one car line only, and this had dingy bob-tail cars, drawn by mules, which, on the heavy grades characterizing the topography of Richmond, made very slow time. The new districts were not reached at all. When the present line was proposed, there were not wanting philosophers who knew that no road would be operated. Even when the tracks were down, these same wiseacres predicted that no cars would ever move over them, and most certainly if they did, the time-honored mule would be called upon for duty. Even after the cars were put on the line experimentally there existed but little faith that success would be reached. But times have changed. The mules on the competing line are to give way to electricity. The citizens of Richmond are the strongest friends of the electric railroad of to-day; and as regards the street railway community elsewhere, the work which the road has done and is doing, and the acceptance of the contract, speak for themselves.

The difficulties we have met are many. One of the most annoying at first experienced was that the cars frequently jumped the tracks. A large portion of the track was, as

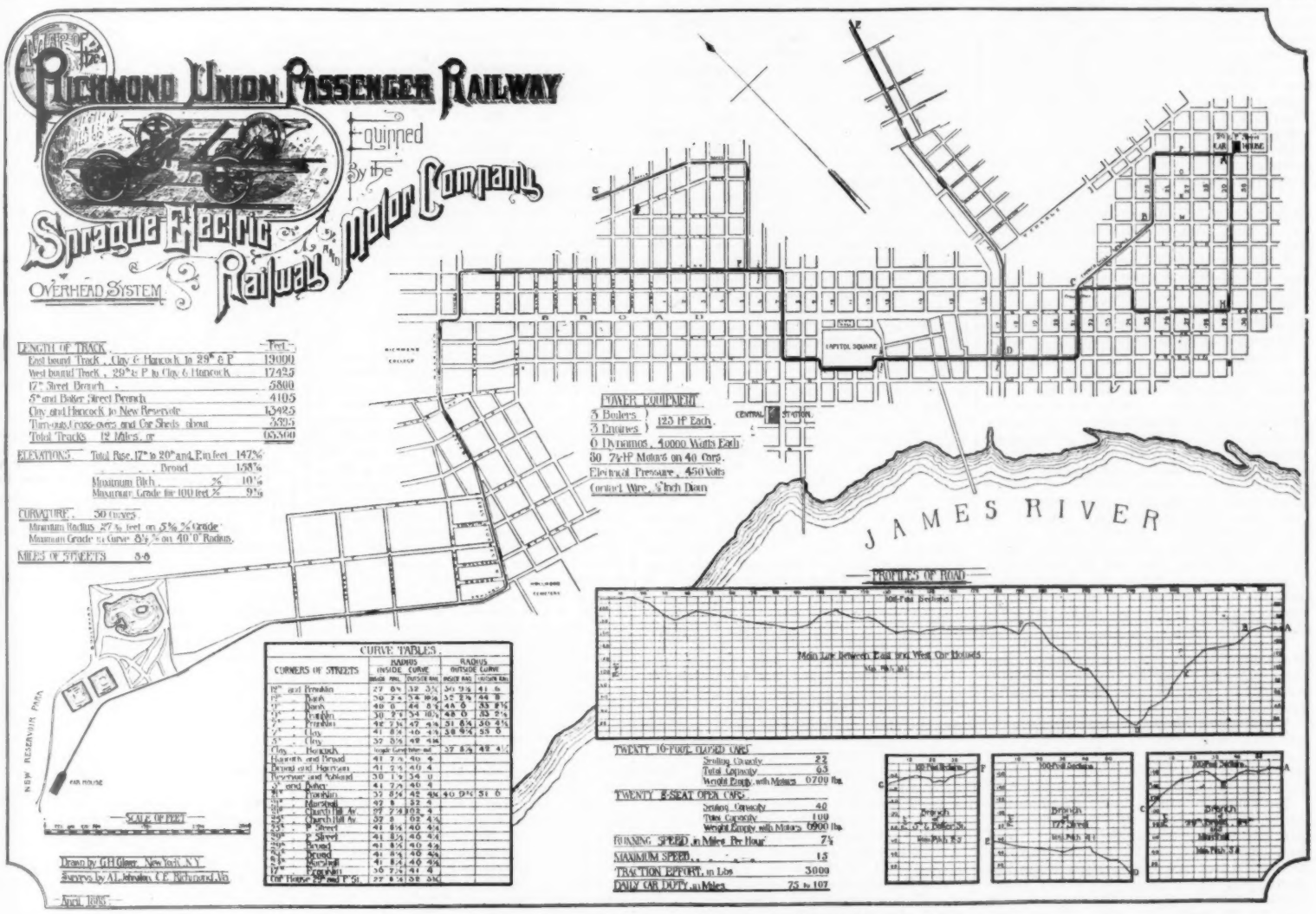

Richmond Union Passenger Railway
Equipped By the
Sprague Electric Railway & Motor Company
Overhead System
LENGTH OF TRACK — Feet
East bound Track, City & Hancock to 29th & P 13000
West bound Track, 29th & P to City & Hancock 17425
17th Street Branch 5800
5th and Baker Street Branch 4105
City and Hancock to New Reservoir 13425
Turn-outs, Cross-overs and Car Sheds about 5325
Total Tracks 12 Miles, or 65560
ELEVATIONS — Total Rise, 17th to 20th and, Fin feet 147½
Broad 158½
Maximum Pitch 2% 10%
Maximum Grade for 100 feet 2% 9%
CURVATURE — 30 Curves
Minimum Radius 27½ feet on 5¾% Grade
Maximum Grade in Curve 8½% on 40'0" Radius.
MILES OF STREETS 5-6
POWER EQUIPMENT
3 Boilers } 125 HP Each.
3 Engines }
6 Dynamos, 40000 Watts Each
30 7½HP Motors on 40 Cars.
Electrical Pressure, 450 Volts
Contact Wire, ⅜ Inch Diam
CURVE TABLES
CORNERS OF STREETS
RADIUS INSIDE CURVE
RADIUS OUTSIDE CURVE
JAMES RIVER
PROFILES OF ROAD
TWENTY 16-FOOT CLOSED CARS
Seating Capacity 22
Total Capacity 63
Weight Empty, with Motors 9700 lbs
TWENTY 8-SEAT OPEN CARS
Seating Capacity 40
Total Capacity 100
Weight Empty, with Motors 9900 lbs
RUNNING SPEED, in Miles Per Hour 7½
MAXIMUM SPEED 15
TRACTION EFFORT, in Lbs 3009
DAILY CAR DUTY, in Miles 75 to 107
SCALE OF FEET
Drawn by G H Glaser, New York, N.Y.
Surveys by A L Johnston, C.E. Richmond, Va.
April, 1888.

FIG. 5.—SURFACE PLAN OF RICHMOND ELECTRIC RAILWAY.—USING SPRAGUE SYSTEM.

current is taken off by a flexibly supported trolley carried on the car, and making contact underneath by upward pressure, as will be more specifically described later.

With such a system put up in the proper manner, it is almost impossible for any accident to occur which will disable the line or prove a hindrance or annoyance to the public in any way.

The wires are perfectly clear of the operations of the firemen, and should they in any place interfere the obstructing section can easily be cut out without disabling the remainder of the system.

The question of "electro-motive force," or electrical pressure, so to speak, to be used, is one of great importance. I do not favor going above 400 volts, and this on a continuous current circuit. This is less than one-seventh the electro-motive force which exists on many of the arc-light circuits in this city; and the current being of a perfectly smooth and continuous character is free from the danger which might be feared from a current of equal electro-motive force of the alternating or pulsating character.

In point of fact, in Richmond, a very large number of our men have received the full E. M. F. from our line without any injury.

On a dry day, the trolley wire has lain coiled up on the ground while the cars are in operation; and while certain changes were being made in the overhead circuit, the men irregular course and reaches the principal parts of the city. About nine miles of street are covered. The central section is a double track for a distance of something over two miles, a part being laid on paved streets, and the balance on Macadam or unpaved streets; all the extension and branch lines are on unpaved streets, many of them in clay soil, which, in wet weather, covers the tracks, and where it would be an impossibility to operate horses without paving. The double track section partly encircles the old State Capitol, and presents difficulties rarely equalled elsewhere. This part of the line, in a distance of less than one thousand feet, has on both east and west-bound tracks, four curves, the inner rails of the west-bound track being of about 27, 30, 40 and 30 foot radius. The power necessary to run these sharp curves is much increased by the fact that grades are encountered on the curves as high as eight per cent., and the lay of the street has required some of the outer rails to be some inches below the inner one. Running eastward from the Capitol, the road descends to a low valley through a series of grades, varying from three to ten per cent., and then ascends a series of sharp grades and curves in a new district, to one of the car houses.

Going west from the State House, the road rises to nearly the highest point in the city, and then runs through a residential

When we first undertook to equip this road in the face of these difficulties, there was the additional discouragement of the ridicule of a great many prominent street railway men and car constructors as well as electricians. It was only a comparatively short time ago that one of the leading lights in street railway circles made a report to the street railway convention in which he stated that unless some new invention should be made it would be impossible for any self-propelled vehicle to satisfactorily operate under the ordinary condition of street-car service. He, as others, held that the grades and curves met in practice were so severe and the condition of the track so bad that a car propelled by its own wheels could not under any possibility, day in and day out, be relied upon to move itself. One electrician even made the statement only a short time ago that any man who should attempt to operate on more than a six per cent. grade would lose his reputation.

Reliability, economy, simplicity of construction and operation on a scale never before attempted and under conditions which we could not foresee. This was the problem, and perhaps it was well we did not know the difficulties. Then again, while there have been strong friends of the enterprise in Richmond itself, there was a class that felt anything but pleasure at a stranger's advent.

The change of feeling with which this enhas been stated, laid in macadam and dirt streets, the latter being chiefly in new districts and in a soil of which the chief component was red or yellow clay, and, although the curves were of a sharp radius, only one guard rail was used, and they were not bound in by paving. The winter months brought frequent and heavy rains. The tracks were found to be settling out of sight in mud, and especially at the curves they were spreading. The cars being large and heavy, with a 4 foot 8½ inch gauge and a 6 foot wheel base, helped to make the curves spread by the tangential pressure of the forward wheels on the outer rails. Mud and stones would get into the grooves, and the cars having a tendency to go ahead, instead of being pulled around by the head as with horses, would climb the track, and before an inexperienced man could check them, the wheels were down five inches in the mud along the stringer pieces and the track brakes hard and fast against the tracks. Sometimes it was lifting, sometimes prying, and sometimes a heavy, hard pull on the part of the motors to get them back again. Experience, however, is a great teacher, and among other things which has been taught is this: that money will be saved by a good track construction and the observance of a few practical points. All curves should be bound in and paved, and this has been done in Richmond. They

should likewise have two guard rails, because it is much easier to steer a car by its rear wheels by holding them in place than by allowing them to crowd the inner rail and force the forward wheels to climb the outer one. In dry weather, with the large wheel base and sharp curves, it is found advisable to grease the grooved rails.

Another point which has to be carefully taken care of is the character of switch which is put in for sidings and cross overs. If drop switches are used, they should be of such character as to allow the car to come down easily; tongue switches are now being put in on all the new work which is being done. It is a rare thing at present to have a car leave the track. I have seen a car in the winter propelled for a hundred feet off the track, and also leave and go back on its own account.

The power house is situated two blocks away from the nearest point of the line, and is almost equi-distant from its extremities. As a distributing point, it is, therefore, both theoretically and practically, a central station. In the construction no expense has been spared, and the performance of the station has justified it. The battery consists of three cylindrical return tubular boilers of the latest pattern, mounted on a Jarvis patent furnace, their capacity being 125 h. p. each. The water is taken from the city mains or from a well. All feed-water connections are of brass pipe. From the pumps the water passes first through the feed-water heater, where it is heated from 150 to 200 degrees F. From there it goes to the filter. The draft in the furnaces is regulated by an automatic steam damper regulator, which, with anything like regular firing, keeps a pressure within two pounds of that for which the regulator is set.

The boilers all feed into one main feed steam pipe, which in turn leads to a separator, a large iron cylinder into which the steam passes, the water falling to the bottom and the dry steam being carried off at the top. All live steam pipes in the boiler room are covered with magnesia.

The present battery occupies less than half the available space in the boiler room, so that four more boilers can easily be put up when it becomes necessary to enlarge the plant. Two more have just been added. An important feature of these boilers, which are the source of power of the whole system, should not be overlooked, that is, the quality of coal burned. Where a very perfect combustion is obtained, a grade of coal can be used which would be impracticable in an ordinary furnace; the mixture at present being used is two parts screenings to one part bituminous, costing from $1.75 to $2 per ton delivered. As the station is only three hundred feet distant from the depots of three railroads, coal can be obtained almost at the door. From the boiler room, both the steam and exhaust pipes run in an underground, mineral-wool-packed trench to the engine-room.

The railroad engines, of which there are at present three, are of the Armington and Sims high-speed type, and develop when running at full load 125 horse-power each at 250 revolutions.

Each engine drives two special Edison dynamos of 44,000 watts capacity each, wound for 500 volts maximum pressure. The dynamos feed into copper "bus" bars, supported on the walls by porcelain insulators.

Each machine has its independent ampere meter, and in addition there is a general ampere meter at the end of the positive "bus" bar. From this bar the current passes to four snap switches, each switch being connected through a three-plug safety switch block, to one of the feeders supplying current to the main line wire. These four feeder wires tap into the line wire at different points, thus maintaining the pressure approximately equal all along the line. At the ends of one of the feeders in the central station, pressure indicators are to be attached which will indicate the voltage at the junction of one of these feeders with the main current wire, and this will serve as a guide.

The electric circuit consists of two parts—the overhead and the ground circuit, each being of compound character. Along the curb stones at distances of 125 feet are thirty-foot poles, inserted into the ground a distance of five feet. Great difficulty was experienced at first on account of the clayey character of the soil, and it became necessary at the corners to put in very heavy poles, which were imbedded in concrete and stones to prevent settling out of place after heavy rains. These poles carry the main circuit which extends throughout the entire length of the roads, and is a copper wire three-sixteenths of an inch in diameter; this is called the main conductor, for on it depends the operation of the road in case of accidents or repairs to the contact wire.

The arrangement of main and working conductor are as already set forth.

This main conductor is, as stated, supplied at widely separated points by feeders, which come from the main supply at the central station. Without the use of these feeders, which can also be reinforced if necessary, the size and cost of the overhead conductors would be very largely increased. The curves are formed of a series of short chords, which approximate the central line of curvature.

The current is taken from this working conductor by a light structure on top of the car. This consists of a low skeleton framework which carries an adjustable swivelling trunnion, having at its upper end a jaw in which is suspended a counter-balanced trolley pole, having at its extension a grooved wheel held by a spring against, and making running flexible contact with, the under side of the working conductor. The flexibility of this arrangement is very great, it being able to follow with perfect facility variations of the trolley wire two or three feet in either horizontal or vertical direction, at any speed, and around any curve. What is all important, it relieves the line of strain instead of adding to it. When getting at the end of the track this trolley trunnion is swung around so as to trend in a proper direction abaft the centre of the car. If off the line it can be replaced from the car quickly and easily in the darkest night. From the trolley the current passes through a protected wire to the lightning arrester and thence to two switches, one at each end of the car, whence after whatever commutation is necessary, it goes to the motor circuits, and thence to the wheel frame.

The return circuit is through the track, and thence by both metallic and ground circuits to the station. Each section of rail is joined to a copper ground wire, which runs throughout the length of the road underneath or alongside the stringer pieces, which is to prevent appreciable differences of potential existing between the rails; as a further precaution, at intervals of 500 ft. this ground wire is connected to an earth plate, and at seven points widely distributed, these ground plates are supplemented by heavy iron pipes sunk into iron ore, or 12-inch water wells, about 25 ft. deep. The ground wire is connected to the station, and there is also a main ground connection made there in a thirty-foot well through a large sink plate, and another to the entire water-works system. Some modifications of the overhead system are now being made which will make it impossible for any accident to one section of the line to disable the remainder; will enable the different sections to be operated independently; and, in case of a fire which may necessitate the blocking or temporary disabling of one part of the line, will allow this section of the line to be cut out of action either automatically or at will.

Each car is fitted with a duplicate and very powerful motor equipment. This is carried entirely beneath the car body, is very compact, out of sight, and necessitates no radical change in the construction of the car. The body had to be stiffened a little and 3 inch steel axles put in. One of the great objections which have been met with in applying motors, whether steam, electrical or of any other character, to the propulsion of street railways, has been the difficulty of getting sufficient track adhesion to operate the car under all conditions of track, loads and grades. Especially was this objection true in Richmond, where it was manifest that no application of a motor system could be fully successful unless the entire weight of the car and its contents was made available for traction.

One of the manifest reasons is, of course, the slippery character of the track under many conditions. Another thing should also be noted, and that is that it is almost impossible in practice to cast all wheels of exactly the same circumference, or at least so that the paths described by the lines of contact shall be the same. Moreover, on curves the wheels are all traveling over paths of different lengths. Theoretically, the wheels should be independently driven, but since this is not possible it follows that the next best thing is to drive each pair of wheels independently. It is a fact which admits of no dispute that there are conditions of track which will not permit of a car being driven from one pair of wheels only, and this difficulty is often augmented by the fact that if one pair of wheels only is used they will sometimes be leading, sometimes following; on heavy grades with one platform reserved for the driver there is a very serious displacement of the centre of gravity and there may be very much more weight upon one pair of wheels than on the other. The whole experience in Richmond has been to emphasize the value and necessity of independently driven axles.

To accomplish this, one motor is centered upon each axle, and to allow the required freedom of motion, and at the same time to preserve perfect parallelism in the meshing of the gears, and also for taking part of the weight of the motor off the body of the axle and to throw it on to the journals, one end of the motor is supported by double compression springs playing upon a loosely suspended bolt, which is supported from a cross girder in the bottom of the car.

The motors are, then, so to speak, weighed or flexibly supported from the car body, and the motion of the armatures is transmitted to the axles through intermediate gearing, of compact form and great strength, so that whenever the axles are in motion there is a spring touch of the pinions upon the gears. Barring friction, a single pound pressure exerted in either direction, would lift or depress the motor a slight amount, and no matter how sudden the strain, whether because of a variation of load or speed, or a reversal of direction of rotation, it is impossible to strip the gears unless the steady strain exceeds the strength of the iron, the pressure on the gears always being a progressive one. The motor armature makes nearly twelve revolutions to each revolution of the car axle.

The motors, although in one sense independent, are connected with duplicate switches at either end of the car, which afford simultaneous control of both machines. These motors, which are of normal capacity of 7½ horse-power each, can for a short time work up to 30 horse-power, and are capable of producing a tractive effort of over three thousand pounds at 50 per cent. efficiency.

The machines are controlled by a single movement switch which effects the various commutations and reversals. They run with fixed brushes in both directions and under all loads. They are run without any covering, and I have no doubt of having street car motors in such condition soon, that that the cars will be run over a pit, and the machines washed down with a hose.

The cars can be run at widely different speeds, varying from the slowest crawl to twelve or more miles per hour. They can be started and stopped without the use of brakes, in the space of three or four inches, and when making the normal running speed can, in an emergency, be stopped and reversed without brakes within less than a quarter of car length. The starting, although prompt, is easy and without shock or jar.

Emergencies sometimes bring out qualities of motors which are unexpected, or which at least if counted on are rarely ever brought into play. On one occasion a man was descending a six per cent. grade with a heavy load when his brake chain parted. Seeing a sharp curve right ahead of him which he knew he would leave if he struck it at the speed he was running, he instantly reversed his machines and brought his car to a stand still, and on the rest of his trip handled his machines entirely with the motors. On another occasion a man passing from behind one car directly in front of another was struck and knocked down by the dashboard. Although the car was moving at a lively gait, the machines were reversed and the wheels stopped within a foot of the man. By any other method of propulsion he would have been killed. Frequently on a ten per cent. grade, with a loaded car, the brakes have been thrown off, the machines reversed, the car stopped and started backward up hill within less than one-half its length, a test of the most remarkable severity.

In noting the control of the car, one is struck at the remarkable character of the traction, and cannot help wondering where it comes from; unquestionably it is in a large measure due to the fact that every pound of weight is available for traction, and that the two axles being independently driven, can take their own speed, and each pair get the best grip.

Another thing to be noted, where the ground circuit is used, is the increase of traction due to the passage of the current from the wheels into the rails. Exactly what molecular action takes place has not been ascertained; it may be simply heating at the contact surface, but the fact remains that the traction is very largely increased. The magnetic condition of the wheels and tracks also has some function in this increase of traction. The wheels and axles are magnetized by the method of motor construction and mounting, and also by the passage of the current through them; the tracks are likewise magnetized by the current passing through them and also by the rolling contact of the wheels. Yet, admitting all these aids, the results have been extraordinary.

Sixteen-foot closed cars carrying picked loads of fifty-five to sixty passengers, and having a total weight of 15,000 pounds, are operated on the 10 per cent. grade, often with a slippery and slimy rail, and on 27-foot curves, without the use of sand or extra help.

These same grades and curves have been ascended without sand after one of the worst sleet storms which has visited this section for years. Various tests under the most unfavorable conditions have been made, cars often being required to cut their way through clay, snow and ice when the tracks were out of sight. No severer test could have been made, and the power and tractive effort developed have exceeded the most sanguine expectations.

Cars have often been stopped and started on the heaviest grades, and in the sharpest curves. One motor has propelled two cars around sharp curves and up six per cent. grades. One car has pushed another of greater weight around the sharpest curves and up seven and eight per cent. grades both straight and combined.

I have no hesitation in saying that with a clean track, and with proper gearing, these cars could mount a 15 per cent. grade, depending on adhesion alone. During the four months operation, although there have been troubles and changes have been made while the cars were running commercially, no car has been pulled a foot by animal power; if any accident has occurred to a motor the car has gone along with one machine, oftentimes with heavy loads and on heavy grades, or in some cases has gone home in company with another car. One hundred and forty men who did not know the difference between a motor and a hand-saw, have been broken into handling these cars, oftentimes with remarkably short training. Up to Saturday May 4, the number of regular cars on duty had not exceeded twenty. On that day at 4 P. M., the hour when traffic becomes exceptionally heavy, we began putting out ten open cars, starting them from the eastern car house alternating with the closed cars, but finally banking them all up at the Old Reservoir. At 6 P. M., they were started home, and shortly afterwards these ten open cars, headed by a closed car, were all run at full speed close together down the eastbound track of Clay street. At one time, fourteen cars were on the line between Clay and Hancock streets and the Old Reservoir, and shortly before 7 o'clock, there were about twenty-two cars on the line between Capitol Square and the Old Reservoir, and at 7 o'clock thirty cars were on the line, the closed cars being very heavily loaded, many of the cars being run with two-minute intervals. The three boilers, whose capacity is 375 h. p., were then supplying three Armington & Sims engines of 125 h. p. capacity, which were driving the six railroad dynamos, and two Westinghouse engines of 110 h. p. capacity, which were driving two alternating current dynamos and exciters, with an equivalent load of 1,060 incandescent lamps. The mixture was enriched, and the firing of boilers became pretty active, there being in addition to the thirty cars badly banked about 110 h. p. taken for lighting.

The highest reading, however, on the line was less than three-quarters of the normal capacity of the dynamos, which were originally intended only for thirty cars, and the average reading for this number was only a trifle over half the normal capacity. Some idea of the effective work of the automatic steam regulator can be formed by an inspection of the steam diagram for May 4 and 5.

The ampere readings taken at intervals of ten and fifteen minutes give a load diagram which is really higher than a continuously recording instrument would show.

The figures which follow, being based upon an actual service increasing from eight to thirty cars, and extending over a period of four months, under the most trying circumstances, and at the most critical and care-requiring period of the enterprise's existence, will give street railway men the most careful and liberal estimate of every possible expense attending the operation of the road which is in any way dependent upon its electrical features. The operating expenses are given under two heads: first, the central station operating expenses, and second, the road operating expenses, the two constituting the total cost of motive power. These are given in detail, and they will probably be found to cover every expense, although in some small ways the distribution of these expenses may be found to be changed by several months longer running. The fuel and other incidental expenses of the station are from the engineers' record, and checked by the readings of the electrial instruments.

For thirty cars running on a double track the central station expenses are about as follows:

$52\frac{42}{100}$ cwt. coal, at 10 cents.	$5.84
$113\frac{70}{100}$ cwt. screenings, at 7 cts.	7.96
5 pints cylinder oil, at 75 cents per gallon	.47
5 pints dynamo oil, at 30 cents per gallon	.18
3 pounds waste, at 10 cents	.30
Water at current rates	3.00
Fuel, etc.	$17.75
1 day engineer	$3.00
1 night engineer	2.25
4 firemen	6.00
1 cleaner	1.50
2 dynamo men	3.50
1 electrician	4.00
Labor	$20.25
Lighting	.50
Depreciation and repairs on dynamos, 3 per cent.	1.50
Depreciation and repairs on engine and boilers, 10 per cent.	4.38
Total central station expenses,	$44.38

or $1.48 per car making 80 miles.

[The central station being operated for twenty-four hours for lighting and power purposes, the lighting company has now assumed charge and rents the power to the cars at $1.60 per day.]

In estimating the road expenses more than liberal allowance is made, but in a new enterprise it is safe to err on this side rather than attempt to claim for a system advantages which will not in practice be borne

out. The expenses are then as follows:

Oil, grease and waste	$4.50	
Brushes	3.00	
Trolleys	2.00	
Material		$9.50
Three mechanics and one helper for thoroughly overhauling motors once a week, making repairs, adjusting brakes, etc.	$7.90	
Four inspectors, two day and two night, for oiling machines and looking after brushes	7.50	
Two night inspectors to thoroughly inspect motors after cars are laid up and see that all bolts, nuts and connections are tight and that everything is in good working order for the morning run	4.00	
One winder and helper for making any repairs which may be necessary and any testing which is required	3.50	
Two linemen	5.00	
Labor		$27.90
Depreciation on car work at 15 per cent	$18.00	
Depreciation on line work at 10 per cent	4.00	
Depreciation		$22.00
Total road operating expenses		$59.40

or $1.98 per car making 80 miles.

The total motive power expenses both in the central station and out on the road would not then exceed $3.46 per car making eighty miles, or 4.32 cents per car mile, and this includes everything except the executive and salary expenses, taxes and insurance, and is less than forty per cent. of the cost of operation by horses with the same number of cars, and under the same conditions.

But the showing is even better than this, for another fact is to be noticed, and it is an important one from an economical point of view. For example, twenty cars on duty for about eighteen hours make a mileage of from 1,500 to 1,800 per day, and if it were not for the fact that the schedule requires them to operate part of the time on a single track with insufficient turn-outs, they could make 1,800 or 1,900 steadily. This, notwithstanding the fact that the speed is limited by municipal regulations. Many of the cars often run 90 to 100 miles. The same mileage and intervals made by twenty electric cars could not, under the circumstances, be made by anything less than twenty-five horse-cars of the same size, and the electric cars probably carry in the aggregate just as many passengers. It follows that to get the same service with horses not only would the number of cars have to be increased, but likewise the number of horses, conductors and drivers. The same mileage performed by horses without these cars and grades, would require a stable equipment of not less than 300 horses.

A good idea of the operation of the system may be obtained from the following weekly table, taken from the records of the railway company up to the present date:

Week ending.	No. of cars put out for regular service.	Avg. No. of cars out per day.	Miles per week.	Avg. miles per day.	Avg. miles per car per day.	Passengers per week.	Avg. passengers per day.
Feb. 8	72	10.3	2,632	376	36.5	18,746	2,680
15	48	6.9	1,211	173	25.2	6,688	956
22	77	1.0	2,604	372	33.6	16,504	2,358
29	91	13.0	4,039	577	44.4	21,944	3,135
Mar. 7	94	13.7	5,047	721	52.6	25,063	3,580
14	86	12.3	5,313	759	61.8	20,897	2,985
21	99	14.1	6,916	988	69.9	30,357	4,337
28	113	16.1	8,621	1,232	76.3	27,076	3,868
Apr. 4	118	16.9	8,351	1,193	70.8	28,260	4,037
11	133	19.0	10,089	1,441	75.9	36,683	5,240
18	133	19.0	10,583	1,512	79.6	40,090	5,727
25	135	19.3	10,895	1,557	80.7	39,040	5,577
May 2	137	19.6	11,309	1,616	82.4	45,330	6,479
9	140	20.0	10,832	1,548	77.4	51,648	7,378
16	176	25.1	11,563	1,652	65.8	58,598	8,371
23	186	26.6	12,128	1,733	65.2	55,163	7,880
30	194	27.7	12,789	1,830	66.1	57,519	8,217
June 5	189	27.0	14,154	2,022	74.9	52,820	7,546
13	187	26.7	14,649	2,093	78.4	59,219	8,459
20	181	25.9	14,371	2,053	79.2	70,965	10,138
Total			178,096			762,648	

With the mileage which is now made, there is an actual saving of about $125 per day in the motive power expenses as against operation by horses. It is hardly necessary to point out that this would pay a good interest on a pretty large investment. The capacity of the road to economically carry passengers has been made so apparent that the old city railway, which was operated by mules and has about 13 miles of track and 50 cars, has been bought up and is to be equipped with motors operated from the same central station. A third line will probably be added, and in the near future every street car, to the number of 100, in Richmond and Manchester will be electrically operated from one station.

From this same station is operated a power and light circuit.

Having thus seen what is possible on a street railway, let us briefly consider the application of electricity on a larger scale.

The failure of the elevated railroads in this city to meet the issue of rapid transit is in no way more forcibly illustrated than by the number of plans which have been brought forward for discussion. No less than eleven have presented themselves, several of which have features in common and claim similar routes; and I will but very briefly review them.

The Beach Pneumatic was merged into the Broadway Underground, and this in turn into the New York Arcade Railway Company, and it is now familiarly known as the Arcade. They propose to run from the Battery, thence to Broadway and Madison Square, with four tracks, the two centre being express tracks, with stations one mile apart, and the two outer tracks for way traffic. Thence the route extends to Fifty-ninth street by Broadway, and to the Harlem River by Madison avenue, with an additional route up the west side of Central Park by the Boulevard or some other avenue, and into the annexed districts. Branches are proposed to connect Broadway and Madison avenue on Twenty-third street, and the two branch roads on Forty-second street.

The Underground Railway Construction Company has pooled the issues of the New York District, New York Underground and the Metropolitan Junction Company. The route of the first is similar to that of the Arcade and runs from the Battery to Broadway and Madison Square with four tracks; thence up Broadway to Fifty-ninth street, and up Madison avenue over the Harlem River to some point near Jerome Park. Branches are also proposed from river to river on Twelfth and Twenty-third streets. The New York Underground road propose to run from the City Hall Park east to Broadway, through Centre and Mulberry streets to Lafayette place and Fourth avenue, at Union Square. Thence by two lines to the Grand Central, and Broadway and Fifty-ninth street, up the Boulevard to Kingsbridge, the main line continuing under Madison avenue to the Harlem River and by a loop to Kingsbridge.

The Metropolitan Junction Company proposes to connect with the two last named in the annexed districts, and then run over the Hudson by a bridge at Washington Heights, connecting with a tunnel through the palisades.

The City Railway Company proposes to begin at South and Whitehall streets, crossing Broadway below Rector, running between Church street and College Place, Sixth and Seventh avenues to Fifty-ninth street and the Boulevard. The line would then run up the west side of Central Park, crossing the Harlem River above Highbridge, terminating in New Rochelle. Branches are proposed for the principal ferries on both rivers, the Post Office and Grand Central Station. The roadway is intended to be 50 wide feet and 12 feet below the street surface; it is to have four tracks, two way and two express. It differs from the other underground railways in that instead of taking the street lines it proposes to purchase the necessary property and erect buildings over the line of the road, which are to be rented for sufficient to pay the bonds of the company. The road thus running through the basements, so to speak, of the buildings, and crossing the streets by tunnels, becomes a covered roadway instead of an open one.

The Terminal Underground Railway proposes a four-track underground railway from the City Hall along the proposed Elm street improvement to the Grand Central Depot.

The Metropolitan Transit Company proposes two elevated steel structures, one on Broadway between Chambers street and Forty-third street, connecting with the Grand Central Depot, and the other on the west side, following the line of the water front

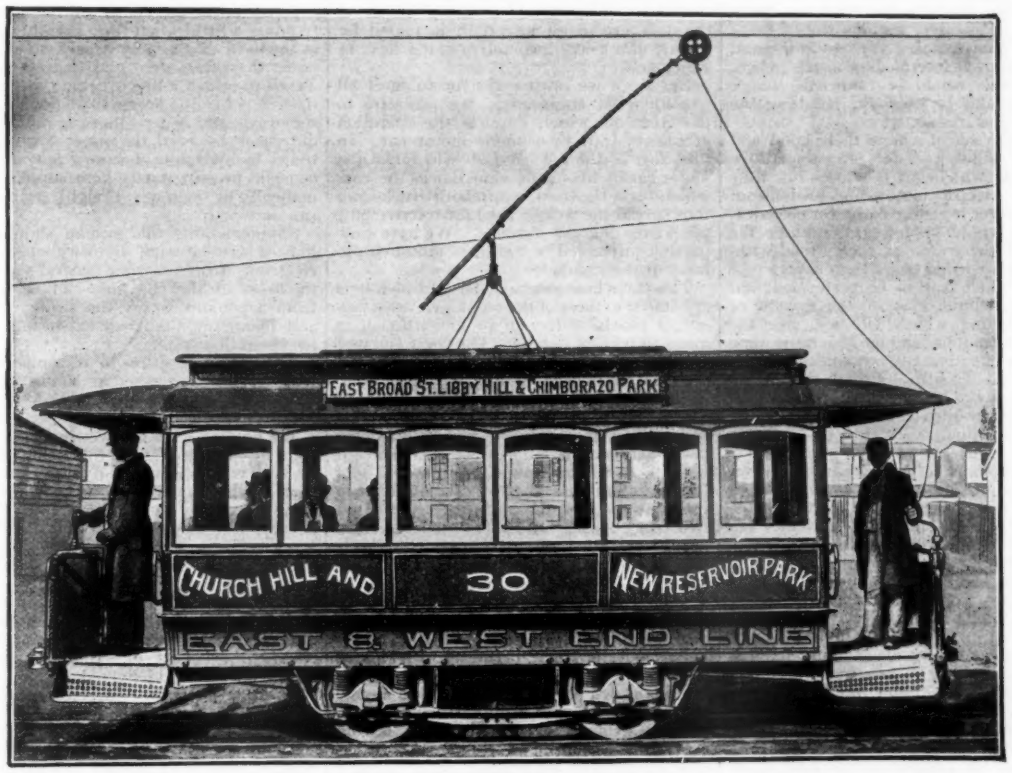


FIG. 6.—VIEW OF CAR AND ATTENDANTS.

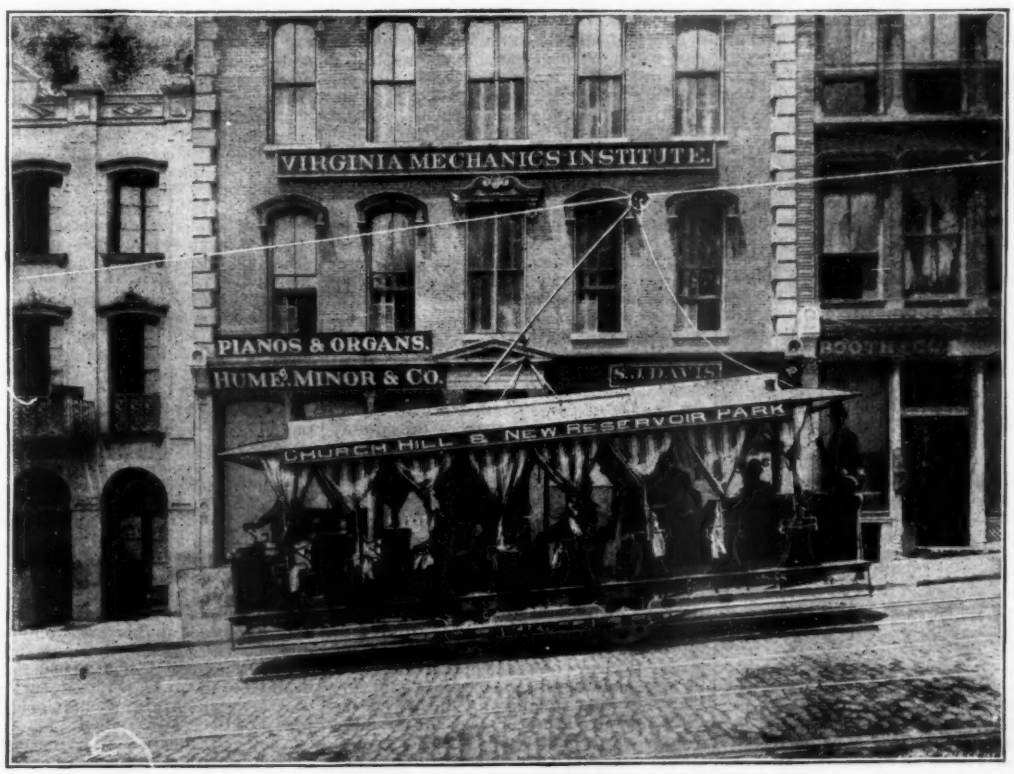


FIG. 7.—LOADED CAR ON GRADE.—RICHMOND ELECTRIC RAILWAY.

to Gansevoort Market, thence up Tenth avenue and the Boulevard to Kingsbridge.

The plant proposed by Heman Clark is one of the most radical. He proposes a four-track tunnel, beginning near Fleetwood Park, cut in solid rock 150 feet below the surface, coming down about 100 feet west of the line of Broadway to the Astor House, where it would connect with two two-track branches, one going under the North River to Jersey City and Newark, and the other under the East River to Brooklyn and Prospect Park. Passenger stations would be at the foot of shafts sunk every two miles, and freight stations at intermediate shafts, where freight pockets would be tunneled. Large elevators would be used for handling the passengers and freight.

All of these schemes have their good and bad points, which I do not propose to here discuss; but whichever is successful, they hope to use electric motors for propulsion. Now, whatever we may claim for electrical motors, it would be folly to attempt the handling of the traffic of such a road without a full knowledge as to the character of the work which has to be performed, and a perfectly definite idea of the system of train dispatching, which will best meet the wants of the public, and at the same time preserve an effective and economical system of operation. To fully consider this, let us briefly review the work which is being done on the elevated railroads, for example on the Third Avenue line.

This is eight and a half miles long. Grades vary from eight to one hundred and five feet to the mile. The level stretches amount to about one-third of the whole distance, and this includes the stations. On the seventeen miles of single track there are fifty-two stations. In the busy hours there are no less than sixty-three four and five-car trains on the tracks. These trains, weighing from eighty to ninety-five tons, make the half trip in forty-two minutes, including stopping at twenty-six stations and discharging and taking on passengers, or at the rate of about ten traffic miles per hour. The works of the engines, which may be divided into three parts, overcoming the train's inertia, lifting the train on the grades and traction, and the maximum is at least seven times that necessary for traction at mean speed on a level. Three times in every mile this weight of 80 to 95 tons must be started from a dead rest, raised to a speed of twenty or more miles an hour, and brought to a rest in about eighty seconds. The engines have to be run with 130 pounds boiler pressure, and have a capacity of 185 h. p. Fifty-nine per cent. of the power on a round trip is used in starting, 24 per cent. in lifting, and 17 per cent. in traction, and the average power developed per minute per round trip, including stoppages, is 70.3 h. p.

The traction necessary to handle these trains is obtained by a locomotive weighing 22½ tons, of which only 15 are carried by drivers five feet apart. With an engine, and the forward trucks of one car between two girders, we have a weight of nearly 1,500 pounds per running foot. The present weight of engines is not sufficient to properly handle these trains when the tracks are in a slippery condition, and it is not wise to increase it. It is absolutely necessary to keep up the high character of the engineering work ot this road, and every consideration of business prudence and public safety will permit of no laxity in this direction. Yet these locomotives have done wonderful work. Although on duty for twenty hours, with steam admitted to the cylinder for six hours only, with an average horse-power of only 38 per cent. of the maximum, and with all the incidental losses of steam, they develop a horse-power with less than a total expenditure of 6.2 pounds of coal per hour, and the coal expense alone is only about $1.15 per round trip, or 2½ cents per train station. The operating expenses are 62 cents per train mile, or allowing an average of four cars per train, 15½ cents per car mile, and this includes everything.

The percentage of expenses of operation and maintenance for the whole Manhattan system may be roughly expressed as follows:

Motive power	42.8
Maintenance of cars	5.4
Movement of traffic	38.4
Maintenance of way	8.2
General expenses	7.2
Total	100.0

The coal alone costs over $700,000 per annum, which is more than the wages of the engineers and firemen, but it is only about one-sixth of the total operating expenses. Hence there are other reasons than merely a saving in coal which must be urged in favor of an electric system as against a steam system.

Generally speaking, the real needs of rapid transit are not best subserved by the handling of long trains from a single tractive engine. True, the conditions of service on the elevated railroad, the crowded condition of the track, and the great cost of operating independent steam engines makes it impracticable to work with small train units there. But the fact remains that the effective length of train which can be operated by any system is limited; that this limit has already been reached on the elevated railroad where only one-sixth of the weight is now effective for traction; and that the smaller the units the less the momentum of the train and the easier it is to quickly and efficiently handle it, and the less will be the liability of, and danger from, any derangement of the brake apparatus. Furthermore, the thrust of the moving weights on the grades, the vibration due to the shifting of the weight along the girders, the tensile, shearing and crushing strains on the structure are all materially increased by the use of a heavy locomotive at the head of a long train.

But since we must endeavor to meet all conditions of engineering, we must try to meet that one which requires the operation of a heavy train by a single motor car. In this case I deem it advisable to make the motor car of about the same size as the cars which form the train, equip both trucks and thus spread the weight used for tractive purposes over a larger distance. We have now partly constructed a 300 h. p. motor equipment of this character.

This car, whose general external dimensions are similar to those of the regular elevated passenger coach, differs in its construction in many important details. The front and rear platforms are inclosed, and about ten feet at each end of the car—that is, the space over the trucks—is partitioned off and reserved for the use of the motor man. The middle space has side entrances, and is fitted for passenger accomodation. At each end of the car the floor framing is raised about twelve inches for a distance of about ten feet from the end, and the car body is carried on two very strong and heavy special iron trucks mounted on forty two-inch wheels fitted with five-inch steel axles. Each axle has an independent movement and is driven by a tandem motor, centred upon the axle, which bears a part of the weight. The motor is also carried by heavy compression springs hung from the truck, by means of which as much of the weight of the motor as is desired can be thrown on to the boxes. Each motor, which is of about 75 h. p. normal capacity, has two armatures, each of which is connected to a fixed and adjustable gear on the axle, the ratio of the gearing being about 1 to 3. These motors will have one brush on each commutator, and that will be a top brush. Each motor has directly over it, in the engineer's room, trap doors fitted with heavy glass panels, which allow the machines to be seen at all times, and through which the machines can always be reached. The controlling devices and switches are all duplicates, and the car can be handled from either end. The car and the trucks are completed; the motors are well under way. The car will be capable of exerting a tractive strain of at least 20,000 pounds—more than double that of the present locomotives.

But this is not the ideal method of traction.

By a system of electrical propulsion, the power can be distributed underneath the cars, every car, or every two cars if need be, being a unit; and, although I do not think it advisable, arrangements could be made for propelling a large number of cars under simultaneous control. By distributing the power under the car, the whole weight of the car and passengers can be made effective for traction. This will enable the cars to be started more promptly, brought to speed more quickly, and stopped in shorter intervals, increasing the mean rate of speed for a given maximum, or *vice versa*, reducing the maximum for a given mean rate. By making cars individual units of locomotion, the intervals between trains may be made one-fourth or one-fifth of the schedule which must exist where four or five-car trains are used. It may be said that this will increase the number of employés that are necessary. This is true, but it will increase the number of passengers who, both day and night, would make use of the system, in such a ratio as would make this increase of expense insignificant.

Let us consider a possible system which would go a long ways towards solving the question of rapid transit. I will briefly point out its features. It would have four tracks, extending from the Battery up Broadway to Twenty-third street, thence diverging in two divisions, each still with four tracks, one along the line of Madison avenue to the Harlem river, and terminating near the Jerome Park district, the other following Broadway and running up the line of the Boulevard and Tenth or Eleventh avenues. Two tracks would be reserved for express traffic, with stations a mile apart, and two for way traffic, with stations every third of a mile, and every third way station corresponding with an express station. The tracks would be arranged in two tiers, the express tracks being the lower. The entire system would be lighted, ventilated and operated by electricity, to be supplied from four stations on the water front—one at the Battery, one at East Twenty-third street, one at Madison avenue crossing of the Harlem river, and one on West One Hundred and Twenty-fifth street; the stations to be operated by compound condensing engines in three units, connecting directly to large, slow moving multipolar dynamos, two engines being of sufficient capacity to handle the demand made upon any station; trains to be operated with one, or at most, two car units; motors to be on the trucks of one car, centred on the axle, and with one reduction of gearing; express speed to be thirty miles an hour, and way trains to make twelve traffic miles per hour; the current to be delivered to the cars by an overhead system with underneath contact, the contact wheel to be carried on the car, supported over the centre of the truck and trending a little abaft it. Freight pockets at the level of the way track could be run under the cross streets at express stations. Track to follow a line of grade of not more than 25 per cent.; access to stations to be by stairways, and where there is any material difference between the street level and the track, by hydraulic elevators, operated from constant pressure tanks kept supplied automatically by motors. Freight trains to be run on way tracks.

Supplementing this system should be a line of surface cars, likewise operated by electricity from the same general source. In the heart of the city these can be operated from a conduit, or by the storage battery, and in all the suburban extensions by the overhead line system.

The objection of loss in transmission and recovery has been raised as against an electric system, and also the question of breaking. These are easily met.

We have systems of electrical breaking a train by the use of its motors, which consists in converting them into dynamos, deriving their driving power from the train, and using up its energy by converting it into electrical energy, which can be used in a variety of ways. In a storage battery system the energy of the car can be made to partially recharge the batteries on a down grade, and in stopping. In a direct supply multiple-arc system, operating a large number of cars, this power of at will being able to convert the energy of a moving train into electrical energy delivered to the line by the same apparatus which controls the speed and powerof the train is of exceptionable importance. In a double track system, the energy given to one track may be communicated to the other just as efficiently as along itself. In fact in the entire electrical system every part is mutually connected, and there is a bond of union between the different trains far more perfect and effective than any mechanical connection could be. The up-grades on one track being equal to the down grades of the other, it is evident that the total up grade of a system is equalized by the down grade thereof. If then, energy is expended in getting under way and climbing up-grades, and a large proportion of this can be recovered in stopping and in running down grade, it is evident that the total initial energy required would be that necessary to remove the trains continuously on level grades, with a percentage for loss in conversion and reconversion added. The more train units which are operated, and the more frequent the stoppages, the more marked is this advantage in an electric system.

I some time since made a number of determinations of a system of the equipment capacity of the Third Avenue Elevated, in which I found that about 40 per cent. of the power could be saved by this system of breaking, where every motor coming to a station or running of a down grade is made a generator which is helping to supply the current needed to operate the remaining trains.

Instead of the current being all supplied by a main generating station at one or two points, it would be supplied from nearly as many moving stations along the line as there would be trains slowing down or running on a down grade. In fact, the loss of the two conversions and one transmission would be more than counter-balanced, and consequently the original horse-power at the central station would be no more than the aggregate net horse-power now developed on the entire line, and this is only about 38 per cent. of the total capacity of the engines. With any given potential and losses on the line, the main conductor would be very much smaller. Not only on the line, but at the central station would be a saving effected; for in a system of the capacity of that which we are considering this saving on lots, buildings, boilers, engines, dynamos and fittings would be not less than $400,000, and there would be about 40 per cent. saving in the coal, labor, depreciation and incidental expenses of the central station.

Another method of using the motors for braking purposes is to break the connection from the line and reverse the machine through a local circuit on the train, varying either the local circuit or the circuits of the machine. While in this position of braking, if the local circuit is opened and the line connection made, the machine would be instantly reversed.

Elaborate experiments were made by me nearly two years ago on the Thirty-fourth street branch of the New York Elevated Railroad, in which these questions of gearing, of mounting the motors on trucks under the car and handling the car without shoe-brakes were very thoroughly studied. There this method of braking was shown to be under the most perfect control. When desired, the braking could be made so sudden as to cause the wheels to have a continuous skidding rotation, not such a skidding as is caused when the air brake is put on too sharply, but a rotating slip which is just enough to relieve the armature when the strain on it reaches the point determined by the co-efficient of adhesion on the rails.

This is the ideal method of braking, because skidding and flat wheels are an impossibility, and the wheels will turn until the train comes to a dead stop, although, where the braking power is put on too suddenly and exceeds the grip of the wheels, they will relieve themselves by slipping just enough to keep the braking at the maximum limit. A train so governed can be made to creep down the maximum grade of a road at a snail's pace, and in an emergency such a car, running at 21 miles an hour on a down grade, has been stopped and reversed within 90 feet.

When an electric motor is reversed its action is cumulative, for so long as its motion continues in its normal direction, it tends to augment the current which flows through it with any given setting of the switch, and thus very much increases the effort to stop itself; and the higher the velocity at which the armature is traveling, the greater this effort. In fact, it would be practically impossible with a properly constructed railroad motor to prevent its reversing when the switch is thrown over far enough. This is another point in which an electric motor has a great advantage over a steam engine.

So it would seem that electricity has practical advantages over steam for this character of traffic, and there are considerations other than purely engineering ones. The use of electricity instead of steam would do much towards making a road of this character popular. We would have express and way trains, starting and stopping smoothly and quickly, moving at a high rate of speed and running at a short intervals. Dust, smoke, cinders, oil and drippings would disappear; the air would be purer and cleaner. The trains would be safer and under more perfect control; motive power would cost less; depreciation on the track structure would be much less; the carrying capacity would be increased; cars would be brilliantly lighted; comfortably heated; in short, everything which would make rapid transit safe, pleasant and effective is possible by a properly developed system of electric traction.

One of the most important sources of revenue from such a system would be the sale of power for stationary purposes. Already we are operating no less than 130 different industries by electric motors, and the receipts vary from $60 to $150 per horse-power. The extent of the application of electricity with any such general source of supply can hardly be conceived. Its profits would be far more than enough to pay the total cost of motive power.

But we must not shut our eyes to the work which has got to be done. We must not exaggerate the advantages of electricity; we must not belittle the position of a system which has been developed by the ablest engineers for the last forty years. All their experience, all their study, all their victories form a magnificent groundwork for us to build upon, and will render the final victory of electricity more easy and certain if we build wisely and take to heart all the lessons which their years of experience teach us. In a small fraction of the forty years which have marked the development of steam engineering, electric engines will rival in mechanical perfection, in construction and performance, the best locomotives. Even to-day, weight for weight, and duty for duty, the electric motor is already rivaling and outstripping its predecessor. For the present, and for a long time to come, it is probable that for trunk-line work and for the original source of our power in an electrical system, we will be dependent upon the steam engine, but we all hope and expect that the future will bring us some other effective means of converting the energy of coal into electrical energy, and that by some direct method which will not require the intervention of a steam engine and dynamo. It is not too much to hope for, and already experiments have been made which foreshadow this great result. The success of this discovery would produce such a revolution in the use and distribution of power as to exceed our most sanguine expectations.

The Eco Watchman's Clock Company, of Boston, has opened a New York branch in the Potter Building.

Messrs. Davison & Driggs, of Newark, N. J., the city of manufactures, are builders of fine machinery that they are introducing into the electrical field. This firm makes a specialty of milling and gear cutting, and have the reputation of giving satisfaction to all patrons, the natural result of the employment of skilled and competent men and the fulfillment of all promises.

ELECTRICAL PATENTS

(opies of any Patents in the following List will be sent to any address on receipt of twenty-five cents.)

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING JULY 9, 1888.

385,705 Arc lamp; James E. Gaston, Fort Worth, Texas.

385,727 Electric motor for street cars; Wilber S. Salisbury, Chicago, Ill.

385,760 Electric battery; William P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Company.

385,770 Protector for electrical instruments; Geo. W. Mingle and William Mingle, Philadelphia, Pa.

385,774 Device for lighting and heating cars by electricity; De Witt C. Roberts, Chicago, Ill., assignor of five-ninths to Charles T. Yerkes, same place.

385,782 Electric switch; Schuyler S. Wheeler, New York, N.Y.

385,787 Electric railway system; Edward M. Bentley, New York, N. Y.

385,815 Electrical switch; Junius E. Mayo, North Manchester, Conn.

385,826 Multiple switchboard; Albert Sechrist, Greeley, Col.

385,846 Wiring switchboards; James A. Cook, Detroit, Mich., and Frank B. Cook, Toledo, Ohio, assignors to the Western Electric Company, Chicago, Ill.

385,863 Multiple switchboard; Milo. G. Kellogg, Hyde, Park, Ill.

385,894 Electrical annunciator; Montraville M. Wood, Erie, Pa.

385,900 Automatic weighing and recording apparatus; Edward H. Amet, Chicago, Ill., assignor to Herbert A. Streeter, same place.

385,902 Electric railway. 385,903 Switch on overhead lines in electric railways; Edward M. Bentley, New York, N. Y.

385,915 Electric conductor; Leo Daft, Plainfield, N. J.

385,927 Coin operated induction coil; Joseph W. Hazell, Baltimore, Md.

385,928 Electric railway; Edwin W. Heald, Wilmington, Del.

385,943 Commutator for dynamo electric machines; Frank B. Mitchell, Columbus, Ohio.

385,956 Electric telephone; Nathaniel Parks, Deansville, N. Y.

385,964 Electric signal for railways; Edward A. Sharp, Rogers' Park, Ill., assignor to William B. Sterrett, New York, N. Y.

385,974 385,976 385,977 Telephone central station apparatus. 385,975 Telephone sub-station apparatus. 385,978 Telephone exchange signaling; Theodore N. Vail, Boston, Mass., and John A. Seely, New York, N. Y.

385,984 Apparatus for tilling ground; Edwin R. Whitney, St. Johnsbury, Vt., assignor to the Standard Electric Company of Vermont, same place.

386,049 Railway signal; George H. Wright, San Francisco, Cal.

386,059 Telegraphic recording apparatus; Chas. Cuttriss, New York, N. Y.

386,066 Electric lock; Frank J. Gridley, Chicago, Ill., assignor to Frederick G. Wheeler, New York, N. Y.

386,071 Magneto electric machine; William Humans, Cambridge, Mass., assignor to the American Magnetic Electric Company, Jersey City, N. J.

386,085 Electric railway. 386,086 Driving mechanism for electric railway cars. 868,087 Combined electric railway and wire conduit. 386,088 Method of welding by electricity; Elias E. Ries, Baltimore, Md., assignor of one-half to Albert H. Henderson, same place.

386,090 Electric battery; Isaiah L. Roberts, Brooklyn, N. Y., assignor to the Roberts-Brevort Electric Company (Limited) of New York.

386,099 Automatic cut-out for incandescent lamps; Merle J. Wightman and Herman Lemp, Hartford, Conn.

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PROF. ANTHONY'S PAPER. In the paper of Prof. W. A. Anthony, on "Overhead Wires," read before the New York Electric Club, reference is made to a work on "Municipal Lighting," containing a resume of the whole subject of underground conductors. Copies of this work may be procured by addressing FRED. H. WHIPPLE, the publisher, Detroit, Mich., Price, $1.00.

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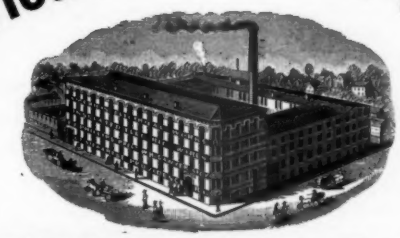

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W. L. MCCULLAGH, AUDITOR.

OFFICE OF THE WESTINGHOUSE ELECTRIC CO.

PITTSBURGH, PA., July 3, 1888.

The Westinghouse Electric Company respectfully calls your attention to the Confidential Circular to the Agents of the Edison Electric Light Company, printed over the signature of E. H. Johnson, President, a reprint of which is given herein; and also to the correspondence which passed between the Officers of the Westinghouse Electric Company and Mr. W. W. Gibbs, Vice President United Gas Improvement Company, of Philadelphia, Mr. Eugene Vanderpoel, President of the Newark Gas Light Company, Newark, N. J., and Chairman of the Executive Committee of the Society of Gas Lighting (for whom a test was made), and Prof. Henry Morton, President of Stevens Institute of Technology, Hoboken, N. J., bearing on the subject matter of the confidential circular of the Edison Company.

We submit this without further comment.

THE WESTINGHOUSE ELECTRIC CO.,
GEO. WESTINGHOUSE, JR., *Pres't.*

CONFIDENTIAL.

[REPRINT.]

To the Agents of the Edison Electric Light Co.:

We are credibly informed that the Westinghouse Company made overtures to the United Gas Improvement Company (of Philadelphia), with a view to have them adopt the Westinghouse system for general introduction throughout the country.

The Westinghouse Company claimed that their system was better than the Edison, and offered to guarantee that the *construction* or *first cost* of a plant would be one-half of that of the Edison, and that the *cost of operation* would be much less.

The United Gas Improvement Company replied that if, instead of the proffered guarantee (upon which they evidently did not place much value), the Westinghouse Company would demonstrate by actual test that their so-called system was *as good as* the Edison, they (the United Gas Improvement Company) would undertake its exploiture and introduction. Competent tests were made of the Westinghouse system at Pittsburgh, Pa., Plainfield, N. J., etc., and of the Edison system in Boston and elswhere. A Westinghouse plant was sent to the Stevens Institute, at Hoboken, N. J., and a thorough test was made by or under the direction of Prof. Morton, assisted by Profs. Denton and Geyer.

The tests were comparative, and made, of course, in the interest and for the information of the United Gas Improvement Company.

An exhaustive report was made, and (as we understand) twenty-four copies printed at a cost of $2,500.

This report has been very effectually suppressed, and in spite of the most strenuous efforts and detective work on the part of some of our friends, we have so far been unable to secure a copy of it. Nevertheless, we have been in communication with several different parties (unknown to one another) who have seen and read the report, and as their statements concerning it completely corroborate each other, we give the conclusions reached by Prof. Morton as they are given to us:

First. Notwithstanding the extravagant claims of cheapness, the construction or first cost of the Westinghouse Alternating or Converting system is practically the same as the Edison.

Second. The Westinghouse Company guarantee twenty lamps per horse-power, and in practice get about six. The Edison Company guarantee twelve lamps per horse-power, and in practice get about fourteen or fifteen. In other words, they cannot come up to the guarantee; we exceed ours.

Third. The *cost of operation* of the Westinghouse system is found by the experts engaged in the test to be very much greater than that of the Edison. This, of course, is the all-important question to the investor.

Fourth. In point of GENERAL EFFICIENCY, RELIABILITY, DISTRIBUTION and REGULATION, the report says that the Edison system is far in advance of the Westinghouse, and that in these essential features the latter is not to be compared with the former.

Although, as before stated, we have not seen this report, nevertheless every one who has seen it gives us the same version of it, and it is known that, as a result of the tests, the United Gas Improvement Company has declined the Westinghouse Company's offer.

We give the information to our agents as it comes to us, in order that they may be aided in their efforts to refute the extravagant and fictitious claims made by the agents of the Westinghouse Company. If the statements made to us are incorrect (which we can hardly believe), our agents might suggest to intending purchasers or investors, that perhaps the Westinghouse Company may be willing to show them the official reports of these tests, on the ground that they will be of greater intrinsic value than the enticing guarantees offered.

The following questions are also pertinent:

1. Why has not the United Gas Improvement Company adopted the Westinghouse system?

2. Why has the report of these tests been so vigorously suppressed?

3. If the Westinghouse Company, as they claim, have a system so superior to and so much cheaper than the Edison, and if, as they pretend, the Edison Company's patents are valueless, why do they desire to bring about a combination with the Edison Company?

The following extract from the New York Sunday "News," of May 27th, is a fair specimen of the reports of this character which are constantly being circulated, and which lack even the faintest suspicion of truth:

BIG CONSOLIDATION OF ELECTRIC COMPANIES.

PITTSBURGH, PA., May 26.—It was current talk in this city to-day, that the Edison Electric Company has offered terms of consolidation with the Westinghouse Electric Company, of Pittsburgh. The terms, it is alleged, are not as yet quite satisfactory to the Westinghouse Company, but that the consolidation of the contending corporations will be speedily effected, is no longer doubted.

Upon investigation we find that this dispatch was received from Pittsburgh by the American Press Association, by whom it was then stereotyped and telegraphed to numerous daily papers all over the country.

4. Why are they constantly importuning Edison experts to come with them, if their own system has reached the state of perfection which they claim for it?

EDISON ELECTRIC LIGHT COMPANY,
BY E. H. JOHNSON, *President.*

[Correspondence between officers of the WESTINGHOUSE ELECTRIC COMPANY and the parties named in Mr. Johnson's Edison Circular.]

PITTSBURGH PA., June 22, 1888.

United Gas Improvement Company, Philadelphia, Pa.:

GENTLEMEN.—We enclose you herewith a type-written copy of a confidential circular issued by the Edison Company to its agents. We shall be glad to hear from you by return mail as to whether, in your opinion, there is any justification for the statements contained in this circular as to your Company having had negotiations of the character referred to.

Yours, very truly, THE WESTINGHOUSE ELECTRIC COMPANY,
GEORGE WESTINGHOUSE, JR., *President.*

UNITED GAS IMPROVEMENT COMPANY.
OFFICE, 333 WALNUT STREET, PHILADELPHIA, June 23, 1888.

George Westinghouse, Jr., Esq., President Westinghouse Electric Co., Pittsburgh, Pa.:

DEAR SIR.—Your favor of 22d inst., which reads as follows, has just come to hand:

> "We enclose you herewith a type-written copy of a confidential circular issued by the Edison Company to its agents. We shall be glad to hear from you by return mail as to whether, in your opinion, there is any justification for the statements contained in this circular as to your Company having had negotiations of the character referred to."

I would reply, in a general way, that so far as the circular makes any reference to the United Gas Improvement Co., which, of course, is the only part of its contents of which I can state of my own knowledge, there is not one particle of foundation for the statements therein contained.

I will answer them specifically:

First. The Westinghouse Company never made overtures to the United Gas Improvement Co., with a view to having them adopt the Westinghouse system for general introduction throughout the country, and therefore of course never made the claims or guarantees set out in the circular.

Second. The United Gas Improvement Co. never having received any such proposition or proffered guarantee could not have made, and did not make, the reply set out in said circular, that "if the Westinghouse Company would demonstrate by actual test that their so-called system was as good as the Edison, that the United Gas Improvement Co. would undertake its exploiture and introduction."

Third. No tests of any kind were made in the interest of or for the information of the United Gas Improvement Co. and no report has ever come to our knowledge of any such tests.

This, I believe, covers the ground fully, and in order to assure myself that none of the other officers or heads of departments of our Company were in possession of any information on the subject of which I was in ignorance, I have submitted your letter and the accompanying copy of circular to a full meeting of our managing committee, which is made up of the heads of all our different departments, and they all unite with me in the above statements. Very truly yours, UNITED GAS IMPROVEMENT CO.

By W. W. GIBBS, *Vice-President.*

PITTSBURGH, PA., June 22, 1888.

Prof. Henry Morton, Stevens Institute, Hoboken, N. J.

DEAR SIR.—We enclose herewith a type-writen copy of a confidential circular issued by the Edison Company to its agents. You will notice that the circular states: "We give the conclusions reached by Prof. Morton, as they are given to us." You can imagine our surprise that the report made by you and your assistants, of which the gentlemen have never supplied us a copy, should be so worded that any one could draw the conclusions that are attributed in this circular. Are the Edison people right in their statement of the case, or have they made a mistake?

Considering the fact that our Company went to a very great expense in the matter of the investigation which was undertaken by you, we feel there is no reason why we should not have been provided with a copy of the reports that were made on our system.

Yours, very truly, THE WESTINGHOUSE ELECTRIC COMPANY,
GEORGE WESTINGHOUSE, JR., *President.*

STEVENS INSTITUTE OF TECHNOLOGY.
HOBOKEN, N. J., June 23, 1888.

George Westinghouse, Jr.:

DEAR SIR.—Yours of the 22d is just received. As regards the action of the Society of Gas Lighting in suppressing my report, I can only say that I had neither voice nor authority in the matter. I only received a copy many months after it was printed, on the condition that I would show it to no one except those engaged in the tests, and no one but Profs. Geyer and Denton has seen it. As to the statement in the Edison circular, I would say as follows: "I never made any tests of any electric lighting system for the United Gas Improvement Co., or made any report on such systems to them." The rest of the statements in the Edison circular are as untrue as their first one, which I contradict as above. I have never said, *in any report to any one*, either exactly or substantially, any of the things attributed to me in said Edison circular. Very truly yours, HENRY MORTON.

Finally Mr. Eugene Vanderpoel, President Newark Gas Light Co., and Chairman of Executive Committee of Society of Gas Lighting, replies as follows:

OFFICE OF NEWARK GAS LIGHT CO.
NEWARK, N. J., June 23, 1888.

George Westinghouse, Jr., Esq.:

DEAR SIR.—Your letter of June 20 has just been received. I have read the confidential letter you enclosed, and find its statements untrue so far as they refer to the report of our committee. The confidential letter states that none of the Edison people have seen the report, and I cannot see that our committee, or the members of the Society of Gas Lighting, who alone have copies of the report, should be held responsible for the imagination of Mr. Johnson.

The United Gas Improvement Company had nothing to do with the report, and have never seen it.

The report was made for and to the Society of Gas Lighting.

The committee, of which I was chairman, several times considered the question of sending you a copy of the report, and all desired to do so, but felt that some of the matter contained in it (although I think you already had the information from other sources) had been obtained confidentially from the Edison people, and we did not think it right to place it in your hands. Neither did we wish that our views, favoring your system so strongly above others, should be used for advertising purposes. We were placed in an awkward position, and thought it would be better to confine the report to the members of the Society. I will at once send your letter to the other members of the committee and get their views, suggesting that, by the removal of the Edison confidential matter, there will be no objection to sending you the report. Yours very truly, EUGENE VANDERPOEL, *President.*

In regard to the rumor reporting consolidation of the Edison and Westinghouse Companies, we would call attention to the following card from the Westinghouse Electric Company, which appeared in the financial column of the *Chronicle Telegraph* of Pistsburgh, May 29th:

A CARD FROM THE WESTINGHOUSE ELECTRIC COMPANY.

To the Financial Editor Chronicle-Telegraph:

Lately there have appeared in your financial columns certain articles and statements relative to the Westinghouse Electric Company which are erroneous and inclined to produce false impressions. You will very greatly oblige the Westinghouse Electric Company by correcting the following more important: The statement with reference to the recent decision against the Edison Company which, as given in your columns, indicates that the Westinghouse Electric Company was the party prominently connected with the suit; whereas, it was a case between the Edison Electric Light Company and the United States Electric Light Company, wherein the pretensions of the Edison Company in reference to a large number of their patents, as set forth in their famous Red Book, were effectually disposed of.

In your last Saturday's issue, also, you headed your financial column "Edison's Greeting to Westinghouse." Nothing has transpired to justify the statements in this article.

Appreciating the position you occupy in financial matters in Pittsburgh, we respectfully call your attention to these facts.

Very truly yours, THE WESTINGHOUSE ELECTRIC CO.